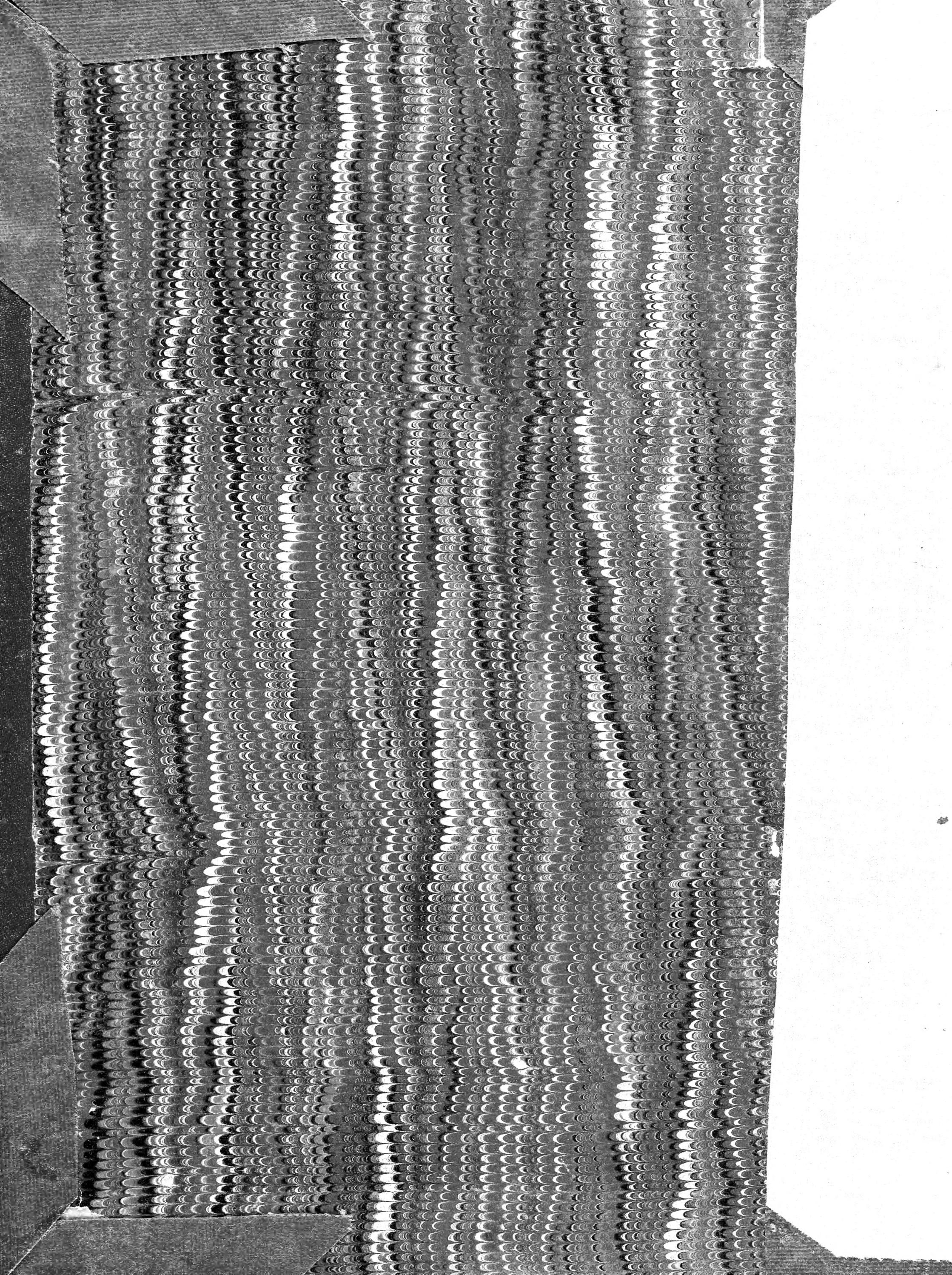
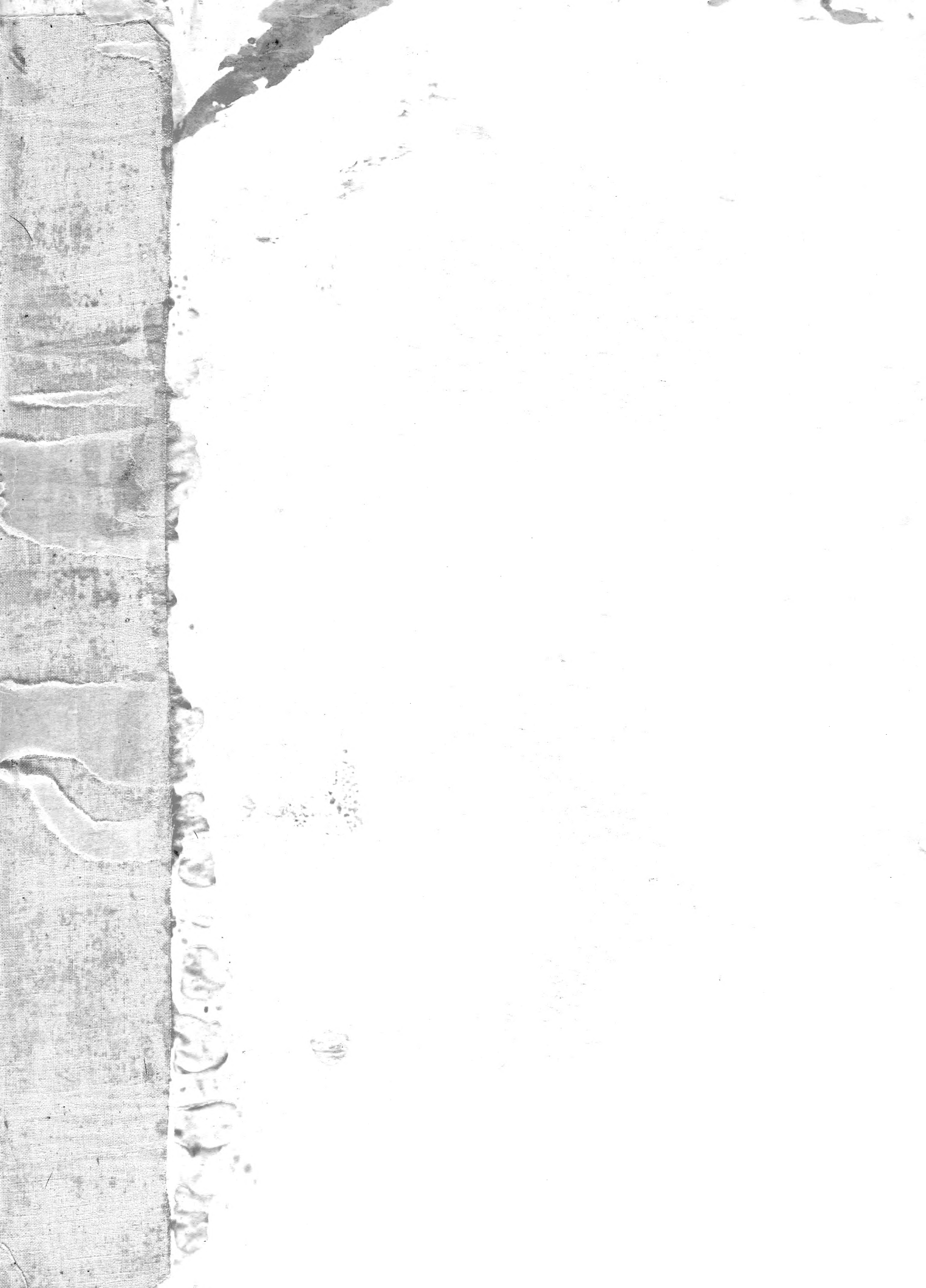


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M E M O I R S
OF THE
GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL,

UNDER THE DIRECTION OF

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SUPERINTENDENT OF THE GEOLOGICAL SURVEY OF INDIA.

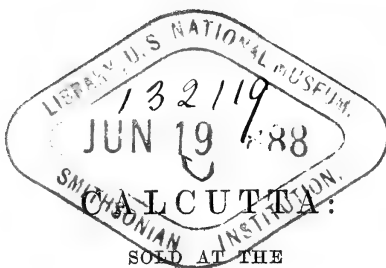
CRETACEOUS FAUNA OF SOUTHERN INDIA.

(Ser. I, III, V, VI, VIII) Vol. III.

The PELECYPODA, with a review of all known Genera of
this class, fossil and recent, by Ferd. Stoliczka,

Ph. D., F. G. S., &c., &c.,

Palæontologist, Geological Survey of India.



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CALCUTTA:

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The third Volume of the *Cretaceous fauna of Southern India*, embracing the bivalved Mollusca, is now completed. This class affords just as perfect evidence of the amazing richness and extent of the Molluscan fauna of that period, as either of the preceding. No less than two hundred and forty-three species representing eighty-five genera will be found described in the following pages.

In the present volume, even more fully than in the preceding, the reader will find himself indebted to Dr. Stoliczka for a full, elaborate and careful review of the whole class of Pelecypoda, in which the analogies of the recent and fossil representatives are ably discussed, as well as for very careful lists of all known cretaceous bivalves. None but those who have themselves attempted such a review can appreciate the amount of labour involved in this undertaking, but every student will gratefully acknowledge the value of such contributions to Science.

The BRACHIOPODA will be the next class to be illustrated, and are now in hand.

THOMAS OLDHAM.

GEOL. SURV. OFFICE: CALCUTTA,
July, 1871.

The fasciculi of the *PALÆONTOLOGIA INDICA* included in the present volume were issued at following dates:—

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„ 5 — 8,	„	223—409,	„	XIII—XXVIII,	„	Mar. 1st, 1871.
„ 9—13,	„	409—end,	„	XXIX—L,	„	Aug. 1st, „

PREFACE.

In introducing the third volume of the South Indian cretaceous fossils, containing a monograph of the Pelecypoda,* I have but few remarks to make.

A general historical sketch, with some notes on the different classes of Mollusca, was given in the introduction to the Gastropoda (Vol. II of Cretaceous Fauna, Palæontologia Indica). I have nothing important to add to those notes.†

The monograph of the Pelecypoda itself, strictly speaking, consists of three divisions: 1, a review of all the known (to me) recent and fossil genera; 2, an enumeration of all the cretaceous species; and 3, descriptions, accompanied with figures, of the species known to occur in the cretaceous deposits of the Trichinopoly and South Arcot Districts of Southern India. A few words on each of these divisions will suffice in the way of explanation.

1. It may perhaps be thought presumptuous on my part to undertake so important a work as to review all the known fossil and recent genera of Pelecypoda. No one will hesitate to admit that a work of this kind is most difficult, and I can only say that I have discharged the duty as best I could with the materials at my disposal, both in respect of specimens and literature.

The reasons why I undertook the work at all were several. When I entered upon the examination of the South Indian Cretaceous Pelecypoda, I found that nearly all the principal groups in this class of Mollusca were represented among them. The importance of a correct generic determination, and the necessity for a comparison of several of the species with others, known from different countries, were obvious; they were in fact rendered essential by the materials of our collection. But the difficulty then arose upon what basis the work should be executed. H. and A. Adams' "Genera of recent Mollusca" appeared to me the only work which I could follow, as I have already had occasion to observe in my introduction to the Gastropoda. Chenu's Manual, the only work which

* *Conchifera*, *Bivalvia*, *Lamellibranchiata*, &c., of other authors, see further on p. 8 and seq.

† Observations on classification of Mollusca, such as those by Prof. Hincks published in the Canadian Journal of Industry, Science, and Arts for 1867, have very little influence upon the advance of the subject. Some others I will notice when occasion offers itself in working out the different classes.

treats the fossil in connection with the recent forms upon the same basis, is incomplete, and in many cases the relations of the fossil to recent types have been entirely mistaken. So far, therefore, as the Indian species, and others required for comparison, were concerned, a necessity arose for a revision of the generic groups to which they belonged. The references to the Cretaceous Pelecypoda in general somewhat enlarged the scope of the undertaking, and it appeared to me then that with a little additional information, the work might prove a very useful compilation. I do not hesitate to say that I was also greatly encouraged in carrying out this review by the many favorable opinions which had reached me regarding similar reviews already given of some of the families of the Gastropoda.

It must, however, be observed that this 'review of the genera' does not pretend to be more than the word expresses. Even as far as completeness goes, the list must be judged only with reference to the materials at my disposal. I wish I had been able to call it a revision, but such would have required a great deal more time, a far superior anatomical and conchological knowledge, and essentially an examination of typical species. Wherever these were accessible to me, I have not omitted to make my characteristics as detailed as I believe to be requisite for purposes of determination. But in a large number of cases my only resources were the scattered notes published about the various genera, or the brief characteristics, which, when based upon imperfect fossil specimens, are necessarily themselves imperfect, and, I am sorry to say, often only too much so. My object, therefore, has necessarily been limited principally to giving a review of the present state of our knowledge, leaving the completion of this to those who have more opportunities of examining typical specimens.

I hardly need to add that I will be greatly indebted for a notice of any corrections or omissions which may be pointed out to me, and will give them publicity with the least possible delay.

The general classification into orders, and partially also that into families, &c., differs considerably from that recorded in any other work on Conchology. I have taken advantage of the examination of the animals of a great many species in various groups, and this in connection with the study of the fossil forms has suggested some alterations, which I have been anxious to introduce in the classification.

Every one acquainted with this subject will be aware that it is most difficult to arrange the Pelecypoda into well defined natural groups. The characters of the

shells cannot always be brought into harmony with those of the animals. Thus, for instance, the shells of the *PAPHIIDÆ* show a great relation to the *MACTRIDÆ*, while the animals are most closely allied to the *TELLINIDÆ*. Again, the animal of a *Lutraria* is that of a *Mya*, while the shell in its hinge character is a slightly modified *Mactra*. The animal of *GLAUCONOMYA* also resembles that of the *MYIDÆ*, while the shell is a somewhat modified *Petricola*. As far as it was possible attention has been paid to the anatomical characters, but these were not allowed altogether to supersede those of the shells.

In order to facilitate an insight into the systematical arrangement, as here carried out, I append (see p. xv et seq.) a list in which all the divisions down to the genera, and in most cases also to sub-genera, with the typical species of each, are entered. This will form in certain respects a supplement, as the names of typical species have not in all cases been referred to in the text. It will be seen from this list that I have classed all the known Pelecypoda into 10 orders, 46 families, and 530 genera, the sub-genera not being specially numbered. How far this arrangement will find approval from Conchologists further researches must show.

2. With reference to the second division of the work, previously alluded to, it will be, I think, convenient to the student to find the lists of cretaceous Pelecypoda, lately published, and partially still in progress, by Prof. Pictet in his *Pal. Suisse*, rendered more complete. I have supplied several omissions in that work, though I have but little doubt that there are many gaps yet to be filled up. My lists must be consulted together with those of Prof. Pictet, for I have not deemed it necessary to swell the record by a repetition of those references to the literature of the subject which are already accurately given in Pictet's elaborate accounts. The species of only the last few families have been compiled independently of that work. Suggestions regarding the correct generic determination of the cretaceous species, so far as materials, or descriptions and illustrations, admitted, have been embodied in the lists.

3. The descriptions of the Indian cretaceous species have been framed with those details believed to be necessary for their identification. Improved materials will naturally call for additions, but when these were too imperfect for purposes of identification, separate specific names have been omitted; a figure of the specimen was, however, usually given. Some conchological and geological details are noticed in the summary on the general character of the Indian cretaceous Pelecypoda (see p. 508).

Before concluding these general remarks, I think it desirable to make some observations regarding the long vexed question of *the priority of names*, in order to justify the procedure which I have adopted in the subsequent records.

Several years since the attention of naturalists was drawn* to the incorrect interpretation of the laws which should regulate the priority of names in Zoology and Botany. The innovation of accepting pre-Linnean names was a few years ago somewhat hastily accepted by a number of naturalists and partially carried out regardless of everything else; but it has equally hastily been abandoned by others.

The British Association Committee devised a rule that the 10th edition of Linné's *Systema Naturæ*, published in 1758, should be taken as the starting point, and that no names given prior to that date should be admitted as possessing right to priority. So far as specific names are concerned, at least in Zoology,† this rule may safely be regarded as correct,‡ but it is decidedly not so with regard to generic§ names. I cannot believe that the rule will ever be accepted by all naturalists in that general form; it is certainly not a Linnean rule as it is supposed by many to be. The rules which should regulate priority of *generic names* had been established with very great detail by Linné himself in his *Phil. Botanica*, §§. 210—250, published in 1750. Some of these were afterwards neglected by Linné himself, and a few others, being impracticable, were superseded by other rules, but most of them have regulated science since their publication in 1750, and are in force up to the present day. I have but little doubt that we are perfectly entitled to go even further back than the year 1750; in fact, I believe, the respect due to the labours of former naturalists dictates this, and the more we become acquainted with the many old literary treasures, the greater will be the number of those who will pay respect to them. It appears to me that the date for the acceptance of generic names should be extended as far back as 1699, the time of writing of Luidius (Llwyd), who was immediately followed by James Petiver and Rumph (Amboin-Rariteitkamer) and others. This is a point which yet requires very close examination. In no case, however, are we entitled to set

* I refer principally to Mr. Mörch's papers in the *Ann. and Mag. Nat. Hist.*, 1857, 3rd ser., vol. II, and in *Malakozool. Blätter*, 1868, vol. XV.

† 1749 would be the proper date for Botany.

‡ The rule of binominal nomenclature is not subject to any alterations by the system which is now being often introduced in consequence of the use of sub-generic names, by which method, strictly speaking, a trinomial nomenclature is produced.

§ The vanity of authorship ought not to be extended to the higher divisions, as families and orders, &c.; they are much too liable to undergo changes by the progress in the examination of the elements of which they are composed.

aside the rules defined in Linné's *Phil. Botanica* of 1750, and names published after that date, that is, between 1750 and 1758, should not on that account alone be disqualified to compete with the rules of priority, of which, as we know, there are a great many. No one will advocate the idea that mere names without description or illustration should be accepted, unless they refer to a well known species quoted as the type of the genus; or that such compound names as '*Catinus lactis*' or '*Mitra hungarica*' ought to be introduced, but what reasonable objection can be entertained against names of Klein, such as *Epidromus*, *Cithara*, *Lagena*, *Avicula*, *Vola*, *Radula*, and many others? They are characterized, and one or two species of each are figured in a work specially devoted to Conchology; they are designated as 'genera' and arranged in classes and sections by a man who may fairly be considered the greatest conchologist of his time. This work with a little alteration would in many respects have done honor to a conchologist of 20 years ago. Some of the generic groups first proposed in the remarkable '*Tentamen Methodi Ostracologicæ*' were re-introduced into our systems only very recently, when by a more comprehensive study of the shells and animals their correctness had become re-established.

Klein as a naturalist, possessing detailed knowledge of natural history objects and the ability to classify them, was far superior to Linné, even in 1734, when he published his '*Naturalis dispositio Echinodermatum*,' while the 1st edition of Linné's *Systema Naturæ* only appeared in 1735. Scarcely any naturalist at the present time would think of objecting to many of Klein's genera of Echinoderms, why then should the conchologists do so to his genera of shells? Even in 1753, the time of Klein's publication of his *Tent. Meth. Ostrac.*, Linné hardly possessed a shadow of Klein's conchological knowledge, as may be readily seen from the *Museum Tessinianum*, which was also published in 1753. Linné never desired that his names should supersede those of other naturalists working before him, as is clear from § 241 of his *Fundament. Bot.* Linné's name stands far too high for any one to attempt to eclipse his labours in natural science, but Mörch justly remarks that when Linné did omit any generic names, or did not acknowledge them, it was either from want of acquaintance with the published literature or from actual want of knowledge of the objects; for he had, until shortly before the publication of his 10th edition of the *Syst. Nat.*, only a comparatively insignificant collection of shells to consult.

I readily admit that we cannot disregard the so-called priority of general use. When a name has been used for nearly a century in all books of natural science,

while another, perhaps published one or two years previously, had the misfortune never to become known, it would be unwise to cancel the well known name and to replace it by another. It is to be regretted that Klein's labours were so little acknowledged by our old veterans in conchology, as, for instance, by Lamarck, who clearly used Klein a great deal, but subjected almost everything to some change or other. If Lamarck had worked out conchology, as regards generic groups, in the spirit indicated by Klein, he would have advanced our science by at least 30 years. However, I will not now dwell upon this subject; the facts are well known. The system of disregarding the generic names given prior to 1758 is not adhered to even by the otherwise strictest devotees of the rule. I may among many celebrated authors only quote Deshayes, who admits Adanson's genera *Pedipes* and *Nerita*, although they bear the date 1757; and surely no sensible man would object to the propriety of this. Others accept still older names unconsciously, but agitate equally ignorantly in favor of the rule.

Another not less important point to which I would briefly allude is, the case relating to a generic name having been proposed to include several varied species, where the type of the genus had not been particularly pointed out. The rules on this question have been also partially established by Linné (in Phil. Bot.) and were emended by the British Association Committee. It is, however, surprising to meet with the inconsequences in reasoning which occur in carrying out the provisions of this rule, particularly in fossil conchology.

Let us take an example: In the second edition of his Paris basin fossils, Deshayes argues, in accordance with the above quoted rule, in favor of the propriety of retaining the generic names *Capsa* of Bruguiér, *Psammobia* and *Sanguinolaria* of Lamarck, *Donax* of Linné, and many others, under which species had been described which no conchologist would at the present time dream of placing in one and the same genus. Mr. Deshayes himself is, however, not consistent in his argument.

Schuhmacher proposed in 1817 a new genus, *Gastrana*, referring to it two species formerly known as *Tellina Abildgardiana* and *Venus monstrosa*. Shortly after it was discovered that the latter species belonged to the genus *Petricola*, suggested by Lamarck already in 1801, but the distinction of the first from *Tellina* was confirmed. What reason then can there exist for not applying to it the name *Gastrana* instead of replacing it by that of *Fragilia* which is of latter date? Mr. Deshayes solves the question. He tells us that it devolves upon the author himself to decide which is the type of the genus, though really in this case only one

species remained to be decided on. Similar strange arguments are used in discussing the priority of the generic names *Paphia* and *Mesodesma*, and of several others.

The argument brought forward is simply, that because an author has described under a generic name several species which are referable to different genera, his generic name should not be accepted. I would hardly notice this want of consequence based upon an untenable argument were it not advocated by, I may say, one of our greatest conchological authorities. Instances such as these ought, I believe, to be pointed out, for they have injurious influence upon the study of fossil conchology, and indeed threaten to affect the principles of scientific nomenclature.

Deshayes by his enormous labours has produced a school of followers some of whom, I may say, accept blindly whatever has been placed on record by him. No independent idea is allowed to establish itself in the mind of the student, and if such has involuntarily pressed itself forward, it is stated with hesitation, the facts are given as not agreeing with those put forward by the great master, but they must not be introduced without his sanction. No other information is listened to, for Deshayes says so and so, &c. A pitiful state of scientific research, and greatly to be regretted! Where are we to look for progress in the study of fossil conchology, if the science loses so many opportunities offered to her of obtaining an insight into the secrets of nature! That so many palæontologists follow Deshayes in their researches may certainly be considered laudable; but that many copy his occasional or accidental mistakes and then even defend these, because they are believed to represent that author's views, is, to say the least, discreditable. Mr. Deshayes would certainly not accept such a compliment.—It is an entirely mistaken opinion to put forth that the scientific man can himself be the only judge of what he has done for science, and that no one else is entitled to give an explanation of his work but himself. And yet Mr. Deshayes brings that argument forward almost every time that it suits him; as, for instance, when it pleases an author to abandon one name and replace it by another without any apparent reason.—An author has no more right to change a name proposed by himself, when once published and adopted in science, than any other fellow worker has.

I can fairly say that I would be the last man to throw the slightest shadow upon the labours of those who did honor to science before many of us were born, but I do hold, that science should remain a republic in which every man is allowed to express freely his own opinion. Nay, science has a right to demand from every one of her servants the expression of an independent opinion derived from direct observation or thought.

I have been led to these remarks solely because I am anxious that the progress which is being made in recent conchology towards a better understanding of the genera and their development should be heartily supported by the researches of the palæontologist, but not stopped, or even retarded. The palæontologist has very often to make certain enquiries, particularly with reference to the strata in which the fossils occur independently of the zoologists, but if true progress in the work is to be attained, the one must utilise the work of the other.

There cannot be the least doubt that Deshayes has done an enormous service to fossil conchology by his conservative ideas. Knowing the difficulties accompanying the examination of fossil shells, often imperfect, he has been eagerly watching over the old Lamarckian genera in order that they may not be split up and then lost for insufficient reasons. The charges which he brought against the classificatory alterations of Schuhmacher, Gray, Swainson, and others, have been almost equally strongly brought forward by him in their favor. Thus, in 1843 Deshayes most strenuously argued that only one genus *Mesodesma* (= *Paphia*) should be accepted in his family *Mesodesmidæ*, but in 1860 he admits exactly the generic divisions which Gray proposed in that family in 1840. I have little hesitation in thinking that Mr. Deshayes will in 1878 admit much of that which was recorded in 1858 by H. and A. Adams in the "Genera," a work with which in 1860 he still found most serious fault.

There is something unusually unsatisfactory to be noticed in the last edition of the Paris fossils. In the review of the various families of the Mollusca it appears, as a rule, to be the intention of the author to give a conspectus of the genera belonging to each family. This conspectus is, however, evidently left incomplete. Many of the generic divisions are there omitted which Deshayes has not only accepted, but himself proposed in his works on recent conchology, as, for instance, in the British Museum catalogues. It would almost appear that Mr. Deshayes believed it as yet unsafe to allow the palæontologist an insight into the variety of forms which the studies in recent conchology have revealed. I can find hardly any other reason to explain the facts, if the family and generic expositions in the 2nd edition of the Paris fossils should be taken as intended to supersede former ideas expressed by Deshayes; and this they certainly do appear to aim at. Again, some generic divisions are pointed out by Deshayes in his general remarks on the families, but are not accepted in the specific descriptions. In other cases the identity of genera (as, for instance, of *Unio* and *Anodonta*)

is strictly argued, but in the specific descriptions the generic distinctions are admitted.—It is not necessary to multiply facts.

With reference to specific names I would notice only two points. I have retained in my descriptions the name of the author who first named and described the species, without regard to any changes which may have subsequently been made in the generic names. The generic change is usually indicated by 'sp.' after the author's name, or by giving his name in brackets*—(); the latter plan is probably better, because simpler and might be generally adopted. Where a generic name is entirely superseded by another, possessing priority over it, as, for instance, *Avicula* over *Pteria*, *Radula* over *Lima*, the indication of the author's name in brackets is not at all required.

The practice of many zoologists, and nearly all botanists, to change the name of the author with every change made in the generic determination has no foundation. The generic name has its author and so has the specific name. If we describe a species, we must accept the name of the author who proposed or first described the species under a specific designation. To make this rule valid, it is only necessary that the specific name be published in connection with a generic one, but it does not necessarily follow that the generic name should be acknowledged by the subsequent author. If we reject the name of the author of a specific name published in connection with a generic one, we acknowledge, besides the generic and specific authorship, a third one, which is only applicable to the combination of both. Why scientific literature should be molested with such personal vanity is really not apparent, unless scientific men do not consider general research in science as common property—which it is. There is little doubt that the time will come when our nomenclature will be so firmly established, that authors' names will become altogether a superfluous appendage which can be dispensed with, but the less the subject is complicated now, the more easily can it be dealt with hereafter.

Lastly, I have not accepted in my descriptions the system which advocates as admissible a repetition of the same name as generic and specific, as, for instance, *Meretrix meretrix*, *Gemma gemma*, &c. I think the practice equivalent to dragging scientific nomenclature into an absurdity. The British Association lately urged the application of the rule that no names which had been used as specific are admissible as generic. This was evidently done with the object of avoiding a

* For sub-generic names I have mostly used another form of parenthesis, viz. [].

repetition of the same name as generic and specific, and also in order to preserve the right of priority of the original specific denominations. It is an excellent rule, but it must not be enforced so as to take *retrospective* effect, it would cause enormous confusion in our nomenclature, and nothing would practically be gained by it. Indeed, I doubt whether it ever would become generally acknowledged. A date should be specified, from which the rule should come into force, and this time should be communicated to all scientific bodies in Europe and abroad : and there is little doubt that in this manner generally applicable results would be obtained.

F. STOLICZKA.

Synoptical list of the families and genera noticed in the present volume, together with the respective type-species.

Sub-kingdom, MOLLUSCA.
Class, PELECYPODA.

ORDERS, FAMILIES, AND GENERA.	TYPICAL SPECIES.	RECENT OR FOSSIL.	PAGE.	ORDERS, FAMILIES, AND GENERA.	TYPICAL SPECIES.	RECENT OR FOSSIL.	PAGE.
Order,—PHOLADACEA	9	Sub-fam.,—BRECHITINÆ	28
Family,—PHOLADIDÆ	9	Genus—
Sub-fam.,—TEREDININÆ	11	35. HUMPHREYA, Gray, 1858 ...	<i>H. Strangei</i> , A. Ad. ...	Rec. ...	28
Genus—	36. BRECHITES, Guett., 1774 ...	<i>B. vaginiferus</i> , Lam. ...	„ ...	28
1. TEREDO, Sell., 1732 ...	<i>T. norvegica</i> , Spengl. ...	Rec. ...	13	36a. [WARNEA], Gray, 1858 ...	<i>B. australis</i> , Chenu ...	„ ...	28
2. UPEROTIS, Guett., 1774 ...	<i>U. clava</i> , Gmel. ...	„ ...	13	37. FOEGIA, Gray, 1840 ...	<i>F. agglutinans</i> , Lam. ...	„ ...	29
3. KUPHUS, Guett., 1774 ...	<i>K. Mannii</i> , Wright ...	„ ...	13	37a. [ARYTENE], Gray, 1840 ...	<i>F. Recluziana</i> , Chenu ...	„ ...	29
4. CALOBATES, Gould, 1862 ...	<i>C. thoracites</i> , Gould ...	„ ...	13	38. PENICILLUS, Gray, 1840 ...	<i>P. aquarius</i> , Burrow ...	„ ...	29
5. NAUSITORIA, Wright, 1864 ...	<i>N. Dunlopii</i> , Wright ...	„ ...	13	38a. [CLEPSYDRA], Gray, 1858 ...	<i>P. strangulatus</i> , Chenu ...	„ ...	29
6. XYLOTRYA, Leach, 1840 ...	<i>X. bipinnata</i> , Turt. ...	„ ...	13	Order,—MYACEA	32
7. TEREDOLITES, Desh., 1842 ...	<i>T. clavatus</i> , Desh. ...	Cret. ...	13	Family,—MYIDÆ	33
8. POLARTHUS, Gabb, 1864 ...	<i>P. americanus</i> , Gabb ...	„ ...	14	Sub-fam.,—CORBULINÆ	34
9. LYRODUS, Gould, 1870 ...	<i>L. chloroticus</i> , Gould ...	Rec. ...	480	Genus—
Sub-fam.,—PHOLADINÆ	17	39. HIMELLA, H. Ad., 1860 ...	<i>H. fluviatilis</i> , Ad. ...	Rec. ...	34
Genus—	40. SPHENIA, Turton, 1822 ...	<i>Sph. Binghami</i> , Turt. ...	„ ...	35
10. TEREDINA, Desh., 1824 ...	<i>T. personata</i> , Lamk. ...	Eoc. ...	18	41. CORBULA, Brug., 1792 ...	<i>C. gibba</i> , Olivi. ...	„ ...	35
11. XYLOPHAGA, Turt., 1822 ...	<i>X. dorsalis</i> , Turt. ...	Rec. ...	19	41a. [PTEROMYA],* Moore, 1861 ...	<i>Pt. Crowcombeia</i> , M. ...	Rhætic
12. GONIOCHASMA, Meek, 1864 ...	<i>G. Stimpsoni</i> , M. and H. ...	Cret. ...	19	42. TÆNIODON, Dunk., 1851 ...	<i>T. ellipticus</i> , Dunk. ...	Lias ...	480
13. TURNUS, Gabb, 1864 ...	<i>T. plenus</i> , Gabb ...	„ ...	19	43. EUCHARIS, Recluz, 1850 ...	<i>Eu. quadrata</i> , Hinds ...	Rec. ...	35
13a. [XYLOPHAGELLA], M., 1864 ...	<i>X. elegantula</i> , M. and H. ...	„ ...	19	(?=Basterotia, Mayer).
14. JOUANNETIA, Desh., 1828 ...	<i>J. globosa</i> , Q. & Gaim. ...	Rec. ...	20	44. PLEURODESMA, Hörnes, 1859 ...	<i>Pl. Mayeri</i> , Hörnes ...	Mio. ...	36
14a. [PHOLADOPSIS], Con., 1849 ...	<i>P. pectinata</i> , Conrad ...	„ ...	20	45. CORBURELLA, Lycett, 1853 ...	<i>C. curtansata</i> , Phil. ...	Jur. ...	36
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* Shell resembling *Corbula*, thin, smooth, or concentrically striated, inequivalve, inequilateral; anterior side short, rounded, posterior produced, obliquely truncate, gaping; left valve with a ridge from the umbo to the postero-inferior end. Hinge unknown. Type, *Pt. Crowcombeia*, Moore, from Rhætic beds at Beer-Crowcombe. Except by its thin structure, this shell does not appear to differ from *Corbula*. It is not stated which of the valves is the larger one, but the figure appears to indicate that the right valve is the larger one, which is also usually the case in *Corbula*.

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* Shaufuss in Pætel's Systeme and Catalogue, p. 18, proposed to substitute the name *Rupicilla* for *Rupicola*, but *Ixartia* is a much older name.
† 'Shell inequilateral, spoon-like process directed backwards', Act. Soc. Linn., Bordeaux, xxvii, vide Zool. Record for 1869, p. 593.

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* I only know this name from the Zoological Record for 1869, where (on p. 587), the reference to 'Act. Soc. Linn., Bord., xxvii', is given.

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* Conrad (Am. Journ. Conch., vol. vi, p. 196,) places *Pachydon*, for which he would rather substitute the name *Anisothyrus*, among the *CORBULINÆ*, but I do not think that its identity with *Goodallia* can be questioned.

† Shell ovately elongated, much compressed, inequilateral, anteriorly much shorter; concentrically striated; umbones very small, curved in; lunule small, deep; hinge with a single, large, elongated, cardinal tooth in each valve; type, *E. Arconatii*, Issel, from the red sea, (Akaba-bay). The characters of the species, as given by Issel, are not sufficient to determine the classification of the genus. In general form it is evidently close to *Goodallia*, but it also exhibits considerable relation to some of the elongated forms of *Loripes*. (Issel, Malacologia del Mar rosso, 1869, p. 85, pl. i, fig. 10).

‡ (? Sub-genera, *Begonia*, *Glans*, *Thecalia* apud H. and A. Adams, Gen. II, p. 489).

§ The type species is said to differ from *Margaritana* by having the gills in their entire length united to the mantle, a small cardinal tubercle in each valve, (Verhandlg. und Mittheilg. des Siebenbürg. Ver. f. Naturw., vol. xvii, 1866, p. 194).

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PELECYPODA

OF THE

CRETACEOUS ROCKS OF SOUTHERN INDIA.

Sub-kingdom, MOLLUSCA.
Class, PELECYPODA, Goldfuss.

CHARACTERS.—*Bilateral, aquatic Mollusca, with the mouth and anus situated at opposite, or nearly opposite, ends, without a distinct head, or any solid buccal plates in the mouth; breathing through partially free lamelliform gills, attached at the sides of the body; effecting their movements by an elongated compressed foot, situated ventrally; enveloped in a mantle which is dorsally always united, in front and behind, and often also ventrally, separated; secreting laterally two equal or sub-equal solid valves which partially, or wholly, cover the fleshy part of the animal, the latter being connected with the valves by one or two strong retractile muscles, while the valves themselves are along the dorsal side joined to each other by more or less distinctly developed hinge-teeth and internal, or external, horny ligaments.*

As I shall often have occasion to allude to the importance of the anatomical characters in the classification of the different orders and families, I will first give a brief general explanatory account of the principal points in the organisation of the class Pelecypoda, and then I will state my reason for having adopted the latter somewhat uncommon denomination.

The form of the body is, with very few exceptions (and these occur in every class), elongated or roundly oval, surrounded by a fleshy mantle, the external edges of which are always partially free and secrete laterally two perlaceous or calcareous valves. The principal variations in the form of the body are—

1st.—Forms represented by the well known ship-worms, in which the posterior part of the animal is greatly prolonged, and secretes a more or less continuous calcareous tube which in some cases encloses the rudimentary valves of the species, in others becomes partially or entirely confluent with them. This elongated form of all the so-called *PHOLADACEA*, which bore in wood, rock or sand, &c., is essentially connected with their habitat.

2nd.—The body is oval or rounded, with two free, equal, or sub-equal, but quite similarly formed valves. To this group by far the largest number of

Pelecypoda belongs; but they exhibit in the different families a great deal of variation as regards the characters relating to the number of hinge-teeth and the position of the ligament.

3rd.—The body is slightly irregularly bilateral, and the two valves are somewhat dissimilar and mostly unequal. This is either produced by one of the valves becoming attached to a solid object (*CHAMIDÆ*, *HIPPURITIDÆ*, *OSTREIDÆ*), or by the animal being temporarily, or permanently, attached with the aid of certain horny filaments, called the byssus (some *PECTINIDÆ*).

The extent to which the margins of the mantle are united or separated exhibits all stages of gradation. The smallest number of openings in the mantle are two, one anteriorly for the protrusion of the foot, the other posteriorly for the siphons, but sometimes when the latter organs are not especially developed, the mantle is open all round, except dorsally. The edge of the mantle is the only place where occasionally (in some of the *ARCIDÆ*, *TRIGONIIDÆ*, *PECTINIDÆ*, and others) small ocelli occur which probably represent the organ of vision.

The mantle is, as a rule, not firmly connected with the shell, except through the retractile muscles, or adductors, of which there are two,—one anteriorly and one posteriorly,—or only one which in that case is nearly central, and represents, I believe, the posterior muscle. Besides these large retractile muscles there are often smaller lateral muscles developed, which partially support the movements of the gills and palpi, partially the foot, and these smaller muscles are generally attached to the shell below the umbones, or close to the large muscular scars. Only in the family *LUCINIDÆ*, and some other closely allied forms, the outer side of the mantle is partially attached by short muscles to the internal layer of the shell, producing certain very characteristic rugosities.

The mantle encloses all the internal organs of the animal, or, at least, within it all the other organs can, as a rule, be retracted.

The mouth is situated always anteriorly close to, a little below and behind, the anterior retractile muscle (if two are present); it is provided on either side with a pair of generally sub-trigonal and internally striated labial appendages, the so-called palpi which only in exceptional cases are nearly rudimentary. Internally the mouth does not possess any kind of a solid radula or buccal plates which are usually found characteristic of the Gastropods.

At each side of the body, there is, as a rule, one pair of lamellar gills which are composed of very thin transverse filaments, and these are again connected by fine longitudinal fibres and covered by a very fine ciliated epithelium which keeps the water in constant motion. Along the base, where the principal artery lies, the gills are attached to the body; the remaining part of them is free, but sometimes the leaves on one side are posteriorly grown together with those of the other side. I have examined one or two animals of almost every family of Pelecypoda, and in all I found that there are at least two gill-lamellæ present on either side,—never a single one,—though they are often unequal, and one of them sometimes, as in the *TELLINIDÆ*, nearly obsolete. In some *ASTARTIDÆ* I observed

occasionally three lamellæ on each side; and in some of the *ARCIDÆ* each gill is so completely folded over on itself as to represent a double lamella. In general appearance and structure the gills of the Pelecypoda do not differ in any way from those of most other aquatic animals, and they perform the same functions of respiration.

The water is supplied to the gills, either through a special siphon which is situated posteriorly below the posterior muscular scar and is produced into a longer or shorter tube, or it has access to the gills within the greater part of the open space of the mantle. However, even in such forms as *Astarte* or *Unio*, in which the mantle-margins are below perfectly disunited, it will be observed in the living animal that, as a rule, the water is admitted to the gills only, or especially, at the place where the inhalant siphon should be situated; this place is provided with elongated cilia and generally kept open, while on the ventral side itself the mantle-margins fit closely against each other. The current of water passes through the inhalant (lower) opening, or siphon, along the inner, lower, or ventral, side of the animal and returns along the attached bases of the gills, issuing from the internal cavity by the upper or exhalant opening, which is either grown together with the inhalant siphon and equally prolonged, or separated from it, and represented by a simple notch or slit in the mantle. Only in the *CRASSATELLIDÆ*, some of the *MYTILACEA*, and in all the *OSTREACEA*, the anal, or exhalant, opening is not specially marked. The continuous current is, however, not sufficient to carry off the water which enters the body by the inhalant siphon, or other openings of the mantle: In almost all Pelecypoda which I observed the body appeared from time to time to contract, the animal generally closing the posterior siphonal openings and ejecting with great force a quantity of water through the pedal and ventral opening. This forcible ejection of the water also often appears to be done with the object of assisting in locomotion.

The foot is a retractile and expansile muscular mass situated on the anterior ventral side; it is variable in size and shape. The most usual form of the foot is sub-cylindrical or somewhat broadly elongated, with the lower anterior edge more or less distinctly sharpened, like that of a hatchet, and hence the name of the entire class. In some families, as in the *SOLENIDÆ*, the foot is club-shaped, but it has the bluntly sharpened edge in front; in some of the *ARCIDÆ*, *NUCULIDÆ*, and allied forms, the sole can be expanded and again folded together, so as to form a sharp, generally serrated edge. In the *ERYCINIDÆ* it is truncate and can be dilated into a kind of disc; only in the *LUCINIDÆ*, and a few species of the *MYTILIDÆ*, it is vermiform, obtusely rounded or truncate at the end. Sometimes there are at the posterior side of the foot certain horny fibres secreted for the purpose of enabling the animal to attach itself permanently, or temporarily, to solid objects; these fibres are called the *byssus*, and in the species which have it developed the foot generally becomes more or less rudimentary, though it never disappears. In some of the attached *OSTREACEA*, the foot, however, becomes obsolete in the full grown animals, but it does exist in the very young ones. Internally the foot is very often hollow and penetrated by an aqueous canal,

which permits the great expansibility of the muscle; its position is regulated by certain muscles attached internally to the shell. There are generally two pairs of these pedal muscles present, one anteriorly and the other posteriorly, each suspended above one of the muscular scars. It does not appear to have been noticed that the byssus of the Pelecypoda is secreted exactly at the same place where in the Gastropoda the operculum is situated, and although both these organs are very differently shaped and developed, and serve entirely different purposes, there exists as to position an unquestionable homology between them.

The food of the Pelecypoda consists of the most minute particles, in a great measure of Infusoria which are brought into the cavity of the body with the water required for respiration. The current of water passes from the siphons anteriorly towards the mouth, and it appears to be the chief function of the labial palps to direct or convey such particles as may serve for food to the mouth, the lips of which are fleshy, but not hardened. A kind of salivary glands has been observed in *Teredo* and allied forms, but it appears to me that these glands are of common occurrence in most of the Pelecypoda,* though as yet apparently not recorded. They consist of a pair of usually very small globular or sub-cylindrical masses which lead by a thin canal into the muscular oesophagus, immediately behind the mouth. The stomach is, as usually in other Mollusca, enveloped in the liver, and so is also a portion of the alimentary canal which does not attain any considerable length; the former often has in front an appendage which is filled with the so-called crystal-style, and which I have also often observed in many Gastropods. The rectum passes through the heart and terminates behind the posterior retractile muscle, where the ejecta pass into the exhalant siphonal opening, or freely between the mantle at the place where the water issues from the body. Besides the liver, the only organ of a peculiar secretive character is a pair of so-called Bojanus'-glands; they are situated posteriorly close to the heart, a little in front and above the posterior retractile muscle. These glands are of a spongy appearance, either of yellowish or violet color, and are partially connected with the heart, partially with the vascular system direct, often admitting water to the pericardium or the heart. It seems certain that to some extent at least these Bojanus'-glands represent the spleen and kidneys; their internal canals either terminate separately close to the generative organs, or together with them in the same opening.

The circulation of the blood has as its central organ a heart which receives from the gills the oxidised blood, though this becomes partially mixed with venous blood just before it enters the heart. The greater part of the venous blood, however, coming from the foot, the mantle, &c., collects either in the Bojanus'-glands, or returns direct to the auricles of the heart. This impurely oxidised, mixed blood issues from the heart in two principal branches – arteries – one leading to the intestines and towards the mouth, the other to the foot; from the former are supplied by repeated branchings the mantle and the palps, from the latter the generative organs.

* I hope to be able to publish some further details on this anatomical subject.

The nervous system consists of three principal pairs of ganglions; the first, or anterior, lies close to, behind, and above the mouth; the second, or middle one, is situated in the foot, and becomes more or less rudimentary with the decreasing size of the latter; this ganglion supplies the ear with nerves and partially also the generative organs; the third, or posterior, ganglion is generally the largest, and situated somewhat in front and below the posterior retractile muscle. The first and last ganglion are never absent; the former supplies the anterior part of the body, including the frontal portion of the mantle, but especially the lips and intestines; the latter provides with nerves the gills and the greater part of the posterior mantle, including the siphons.

There are no special organs of touch which are principally situated in the fleshy marginal portions of the mantle and in the extremities of the siphons and of the foot; the palps appear to be concerned in the action of this organ only with reference to the food which passes towards the mouth. No special and permanent eyes are present in any of the Pelecypoda, and the only organs representing them are the ocelli which have been observed at the edges of the mantle of some *ARCIDÆ*, *PECTINIDÆ*, and others. As regard their structure, these ocelli, however, quite correspond to the eyes of other Mollusca, and each is supplied with a short special nerve. The ear consists of a pair of small cavities, situated in the muscular tissue of the foot; each has a large otholite, and is supplied with nerves from the pedal ganglion.

Most of the Pelecypoda are of distinct sexes, only some of the sessile or permanently attached forms being hermaphrodites. The sexual organs are situated in the posterior part of the body, close to the Bojanus'-glands and, like these, generally consist of two glands. In the early stages the glands in the different sexes are very similarly formed; it is only when the spermatozoa on the one hand and the eggs on the other are more developed that the sexual distinction can be recognized with sufficient certainty. The fructification of the eggs appears to take place through the water, with which the spermatozoa enter the body of the female; but direct observations on this point are as yet very few and not very satisfactory. It is, however, certain that the eggs generally attain a very high state of development in the body of the females, and that—evidently in order to be able to retain the large number of eggs,—the females are often distinguished from the males by a more ventricose form and a larger size. Sometimes the embryos remain in the body of the mother till they attain a perfect form with a well developed shell. A few species, as in *Galeomma*, *Lasaea* (= *Kellia*), and others, are said to be viviparous.

The development of the Pelecypoda in the egg from its earliest stage is much similar to that of other higher organised aquatic Mollusca. With the exception of the presence of a peculiar flagellum during the earliest stage of age, and the occasional presence of little ocelli or eyes at the base of the labial palps, there is nothing peculiar in their metamorphosis, and the secretion of the shell begins at a very early period of age.

The principal variations in the form of the shells have been already alluded to in the account relating to the general form of the body. In the typical forms there are always two valves present which correspond to the sides of the body, and into which all the soft organs of the animal are retractible. The *PHOLADACEA* form in part an exception of this, the true valves being sometimes reduced to a very small size, while the posterior part of the body with the siphons is greatly prolonged and secretes a special calcareous tube. In all the other orders of the Pelecypoda the valves are, when free, either perfectly *equal* or *sub-equal*; when one of the valves is permanently *attached*, the *free* valve is mostly somewhat smaller, while the other grows somewhat irregularly, adapting itself to the object upon which it is sessile. The external ornamentation of these foreign objects is, however, generally transferred to one or both the valves of the sessile shell.

The principal increase of the valves takes place at their periphery, the shell mass being secreted by the edges of the mantle, which when entire produce a simple striation, more or less regularly concentric with reference to the position of the umbones; but when they are undulating or dentate, the formation of various radiating striæ and ribs on the shell surface is the consequence. Thus, considering these two kinds of secretion, we shall have naturally to divide the ornamentation of the shell-surface of Pelecypoda into a *concentric* and a *radiating* one; the other terms relating to striæ, ribs, spines, tubercles, &c., are only relative and easily intelligible; they refer more to the character of individual specimens than to that of the larger and more general divisions.

The terminology of the parts depends on the position in which the shell is placed; and in regard to this important point two views are upheld by naturalists. The one adopts the position, with the beaks laterally, the anterior end turned below, and the posterior, or siphonal, above,—the other, the position with the beaks uppermost, and the two ends anterior and posterior, as the more natural one. I shall conform to the latter view which, though the older one, certainly appears to me the more correct and more natural one, at least as far as the greater number of the typical groups of Pelecypoda is concerned.

The shell being placed in such a position that the umbones are situated above the oral end anteriorly and the siphonal end posteriorly will define our terminology. The shells will, therefore, be classed first as *equi-* or *inequi-lateral*. It is usual that the umbones are incurved towards the anterior end, but opposite cases are not uncommon. The margin of the shell just below and in front of the umbones is called the *lunular*, that behind the beaks, where the ligament is attached, if external, the *areal*. If the regions of these two margins are particularly circumscribed by lines or ribs, being either peculiarly excavated or elevated, the names *lunula* and *area* are commonly applied to them. The *ventral* margin becomes in the above noted position of the shell the *lower*, and is naturally so; at the anterior part of it the foot protrudes, and this is, as a rule, much more often the natural position of the Pelecypoda, when moving in the mud or sand, than that the anterior part should

be turned perpendicularly downwards, a position which is actually only to be naturally observed in many *MYACEA*, but rarely in any of the other orders. The terms *anterior* and *posterior declivity* are identical with *lunular* and *areal slope*, and are restricted to the dorsal, generally convex, region of the animal and shell.

The valves composing the shell either fit closely with their margins together, or they form a gape anteriorly, or posteriorly, or ventrally, mostly at the place where the foot protrudes; the valves are consequently termed either *closed* or *gaping*. The distance from the anterior end to the posterior will be spoken of as the *length* of the shell, and in the measurements given the extreme length will be always recorded. A line drawn from the top of the umbo perpendicularly upon the length and extending to the opposite ventral margin will be understood as the *height*; and the shortest straight line between the greatest convexities of the valves will be noted as *thickness*. The terms *right* and *left* valve are self-understood from the above noted position. The side of the shell where the mouth of the animal is situated and nearer to which, as a rule, the foot protrudes is the *anterior*, it is in a greater number of Pelecypoda also the shorter one. The only slightly confusing difficulty arises in case of the shells living attached, their form being then often greatly altered; but even as regards these I shall retain the same uniform terminology, placing them always in such a position that the umbones are situated above, and the margins of the lunular and areal declivities either in a horizontal line or sloping under similar angles, as the case may be. The terms *attached*, or *larger*, and *free*, or *smaller*, *valve* may often be conveniently used, without in any way interfering with the above terminology.

The expressions of cardinal and lateral teeth, external ligament, fulcra or nymphæ, internal ligament or cartilage, cartilage processes, or pits, pallial and muscular impressions, &c., are so commonly and uniformly used that I do not need relate them here in detail.

The extent to which the mantle-margins are united or separated, the form and number of the retractile muscles, the shape of the labial palps, gills, siphons, and of the foot, together with the general form and structure of the shells, the position of the ligament and cartilage, and the form, number, and disposition of the hinge-teeth, supply the principal distinctions upon which our classification into orders and families is chiefly based.

I now return to the question concerning the propriety of the term Pelecypoda, which I have here adopted for this class of Mollusca. It is essential that this point should be discussed upon all its merits.

One of the oldest names applied to this class is that of *DITHYRA*, first used for it by Aristotle. It was very early (1681) changed into *BIVALVIA*, and by Lamarck (1818) into *CONCHIFERA*. Both the latter names became very popular among conchologists, while Turton and Swainson again introduced the original appellation of Aristotle, though not with success.

Blainville, having regard to the lamellar shape of the gills, proposed (1814) the name *LAMELLIBRANCHIATA*; sometime afterwards (1828) the more correctly

derived name *ELATOBANCHIATA* was substituted for it by Menke, and a little later (1830) replaced by *ELATOBANCHIA*.

In 1820 Goldfuss proposed in his Manual of Zoology the name *PELECYPODA*, evidently with the object of obtaining uniformity with the nomenclature of the other classes of Mollusca, the Cephalopoda, Gastropoda, Brachiopoda, &c. The name Pelecypoda has regard to the very usual hatchet-shape of the foot, its presence and form* being indeed even more constant than in the Gastropoda. Burmeister suggested in 1843 the name *CORMOPODA*, evidently having the same object in view as Goldfuss had, but I do not think that the latter name is equally characteristic as the former; at any rate, it is no improvement upon it. At last Bronn suggested in 1861 the name *ELATOCEPHALA*, though he rather appears to have expressed himself in favor of Menke's *ELATOBANCHIA*.

Looking at the various names, as noted above, I would at first observe regarding their derivation that an attempt evidently has been made to obtain a denomination which is taken from one of the principal characters of the Mollusca, and, therefore, it seems not desirable that the number should be increased by any other new name, unless its greater usefulness and propriety has been fully established. In making, therefore, a selection from the existing materials, it seems to me not only extremely convenient and desirable, but also natural, that we should observe a uniformity in the denomination of the various classes of the sub-kingdom Mollusca, provided, we admit that those classes are merely modifications of one — the molluscous-type, (an opinion upon which, I believe, there is hardly a division among naturalists), and that the classes represent those modifications as developed in some or other principal organ.

The names *BIVALVIA* and *CONCHIFERA* have been rejected, because there are other classes of Mollusca and other animals (Brachiopoda, Cirrhipeda, Entomostraca) which possess two valves, while there is nothing in the names which would sufficiently characterize the class, and which could be used for a uniform denomination. The names *LAMELLIBRANCHIATA*, or *ELATOBANCHIA*, have, on the contrary, been thought very appropriate, but it is clear that the same objection applies to them, as to the two former names: First, there is nothing characteristic or peculiar in the lamellar shape of the gills which does not occur in other, chiefly higher organised, aquatic animals; and then the single fact, that there are Mollusca with lungs as well as with gills, and some without either of them, makes the term — *branchia* not eligible. The third name is Bronn's *ELATOCEPHALA*. I have due regard to the importance of cephalisation in classification, but I believe the name is here very inappropriately used. The single fact, that the present class had first been referred to the larger division, "*MOLLUSCA ACEPHALA*," and then immediately called "*ELATOCEPHALA*," speaks against it.

None of the above objections are directly applicable to the name Pelecypoda; it not only admits a uniformity in the denomination of the different classes of the

* I would recommend to those who object to the term Pelecypoda, on the plea that the foot of these animals is not always hatchet-shaped, the study of the various forms of hatchets and battle-axes of the middle age.

Mollusca,* but it also attains this in a way which makes due reference to the modification of one of the most important—the locomotive—organ of the animals. And this is what led me to decide for the name *PELECYPODA* in preference to any other, though I am well aware that it has not yet come into general use, but, I believe, it has been unduly neglected. I have given my argument in favor of it, and leave the rest to the opinion of more able classifiers than myself.

The class Pelecypoda has been variously sub-divided by authors on Conchology or Malacology. The propositions of the different systems are recorded in almost every malacological treatise, and there is not, therefore, any sufficient reason that I should note them here at any length. The usual classification is that in *DI-* and *MONO-MYARIA*, the former being sub-divided again into *SINU-* and *INTEGRO-PALLIATA*. Deshayes in his last edition of the Paris fossils accepts the general term *MOLLUSCA ACEPHALA*, and defines three sub-classes — *ACEPHALA DIMYARIA*, *ACEPHALA MONOMYARIA*, and *BRACHIOPODA*. The last is very different in organization, and should be left out altogether from the present field of observation.

I have carefully considered Deshayes' observations regarding the differences which he points out in the muscular and nervous systems of his *MONOMYARIA*, as compared with those of the *DIMYARIA*, and, I believe, they will not be greatly supported by the thorough anatomical examination of the animals; they certainly do not apply to several of the *MONOMYARIA* which I have examined. The distinction as to the presence of one or two retractile muscles appears to me to be not an essential one; the *MYTILACEA* clearly show that the distinction cannot be maintained, with the result of a rational classification. Neither do I find the differences pointed out in the nervous system between the two divisions confirmed. Quite the same remark applies to the supposed distinction of *SINU-* and *INTEGRO-PALLIATA*. There is barely a single family of Pelecypoda in which we would not find both the groups represented; take, for instance, *Mya*, *Tugonia*, and *Cryptomya*; *Lutraria* and *Anatinella*; *Donax* and *Tancredia*; *Cytherea* and *Dosinia*; *Trapezium* and *Coralliophaga*; *Nuculana* and *Nucula*; the various forms of *Dreissena* and *Mytilus*, &c., &c. I do not see the benefit of these divisions; and I believe that the most natural course we can adopt is to group the Pelecypoda according to the principal types, which represent, so to say, the starting points, or centres, of the variously developed or organised forms. This mode of classification, being based at the same time upon the genealogical development, has been found to be the most successful also in the other large divisions of the animal kingdom, though I readily admit that the great difficulty in making this classification really a natural one rests in the discovery and correct definition of those so-called principal types. In the present state of our knowledge of the Mollusca, we cannot pretend to say that we are already in possession of the materials for such a successful *natural* classification, and every attempt towards it must, therefore, be looked upon only as such.

* Cephalopoda, Gastropoda, Pelecypoda, Brachiopoda, Saccopoda, Ciliipoda,—see introduction to my Monograph of the South Indian Cretaceous Gastropoda, Pal. Ind., Vol. II.

I do not need to repeat here the importance of the study of the fossil forms of Pelecypoda in order to attain this object of natural classification; and I will only append a table showing the different groups, &c., which I shall adopt in the course of my monograph. The characteristics of each order, family, &c., will be found in their respective places; and the reason for doing this has already been explained in the preface. I begin with what I consider the highest order.

Class,—PELECYPODA.

I. Order,—PHOLADACEA.

- 1.—*Family PHOLADIDÆ*, (*sub-fam. TEREDININÆ* and *PHOLADINÆ*).
2. „ *GASTROCHÆNIDÆ*, (*sub-fam. GASTROCHÆNINÆ*, *CLAVAGELINÆ*, *BRECHITINÆ*).

II. Order,—MYACEA.

- 3.—*Family MYIDÆ*, (*sub-fam. CORBULINÆ* and *MYINÆ*).
4. „ *MACTRIDÆ*, (*sub-fam. LUTRARIINÆ* and *MACTRINÆ*).
5. „ *ANATINIDÆ*, (*sub-fam. PANDORINÆ*, *THRACIINÆ*, *ANATININÆ*).
6. „ *SAXICAVIDÆ*.
7. „ *GLAUCONOMYIDÆ*.
8. „ *SOLENIIDÆ*, (*sub-fam. SOLENINÆ* and *PHARELLINÆ*).

III. Order,—TELLINACEA.

- 9.—*Family PAPHIIDÆ*.
10. „ *SCROBICULARIIDÆ*, (*sub-fam. CUMINGIINÆ* and *SEMELINÆ*).
11. „ *TELLINIDÆ*, (*sub-fam. GARINÆ*, *TELLININÆ*, and *CAPSINÆ*).
12. „ *DONACIDÆ*.

IV. Order,—VENERACEA.

- 13.—*Family PETRICOLIDÆ*.
14. „ *VENERIDÆ*, (*sub-fam. TAPESINÆ*, *VENERINÆ*, *SUNETTINÆ*, *DOSLININÆ*).
15. „ *GLOSSIDÆ*.
16. „ *CYRENIDÆ*.
17. „ *CARDIIDÆ*, (*sub-fam. CARDIINÆ* and *LYMNOCARDIINÆ*).

V. Order,—CHAMACEA.

- 18.—*Family VERTICORDIIDÆ*.
19. „ *TRIDACNIDÆ*.
20. „ *CHAMIDÆ*.
21. „ *CHAMOSTREIDÆ*.
22. „ *HIPPURITIDÆ*.

VI. Order,—LUCINACEA.

- 23.—*Family LUCINIDÆ*, (*sub-fam. CORBINÆ* and *LUCININÆ*).
 24. „ *UNGULINIDÆ*.
 25. „ *ERYCINIDÆ*.
 26. „ *GALEOMMIDÆ*.
 27. „ *SOLEMYIDÆ*.
 28. „ *ASTARTIDÆ*, (*sub-fam. ASTARTINÆ* and *CARDITINÆ*).
 29. „ *CRASSATELLIDÆ*.

VII. Order,—UNIONACEA.

- 30.—*Family UNIONIDÆ*, (*sub-fam. UNIONINÆ* and *MYCETOPINÆ*).
 31. „ *MUTELIDÆ*.
 32. „ *ÆTHERIIDÆ*.

VIII. Order,—ARCACEA.

- 33.—*Family TRIGONIIDÆ*.
 34. „ *NUCULANIDÆ*, (*sub-fam. NUCULANINÆ* and *MALLETINÆ*).
 35. „ *NUCULIDÆ*, (*sub-fam. NUCULINÆ* and *SAREPTINÆ*).
 36. „ *ARCIDÆ*, (*sub-fam. AXINÆINÆ* and *ARCINÆ*).

IX. Order,—MYTILACEA.

- 37.—*Family PRASINIDÆ*.
 38. „ *MYTILIDÆ*.
 39. „ *PINNIDÆ*.
 40. „ *AVICULIDÆ*, (*sub-fam. AVICULINÆ*, *VULSELLINÆ*, *MELININÆ*).

X. Order,—OSTREACEA.

- 41.—*Family SPONDYLIDÆ*.
 42. „ *RADULIDÆ*.
 43. „ *PECTINIDÆ*.
 44. „ *OSTREIDÆ*.
 45. „ *PLACUNIDÆ*.
 46. „ *ANOMIIDÆ*.

Taking a very general view of these orders the following summary may be interesting in point of comparison. The animals of the first order are chiefly distinguished by having the gills prolonged into the siphons, the second by possessing united siphons covered by an extension of the epidermis of the shell, but no prolonged gills. In both these orders the mantle-margins and siphons are united, and the latter equally prolonged. The third order represents the type with long but entirely separated siphons, the fourth with short and separated siphons; both have the mantle-margins widely open in front. The fifth order appears to be an aberrant type of the second, having the mantle-margins united, but possessing the short siphons of the fourth order, and a habitat which corresponds with the

OSTREIDÆ. The sixth and seventh orders represent the types of Pelecypoda with only an anal opening and widely disunited mantle-margins; both differ in habitat, the former including marine and estuary, the latter fresh-water inhabitants. The eighth order is principally characterized by entirely disunited mantle-margins and usual total want of siphons; the ninth by having two very unequal retractile muscles, the anterior being small and sometimes nearly obsolete, the posterior much larger. The last order is, strictly speaking, the only one in which the anterior retractor is obsolete, or very nearly so, while the posterior large retractor assumes an almost central position. However, it must be borne in mind that these remarks are intended to apply only to the principal types, and that aberrant and representative forms are everywhere to be met with, as I had already occasion to note. They are the natural consequence of the course of development under different conditions.

I shall conclude these remarks with a very brief and general notice regarding the distribution of the Pelecypoda in time and space.

The Pelecypoda are found in all sedimentary formations from the earliest time. In the Silurian period their number is, though smaller than that of the Brachiopoda and Cephalopoda, still somewhat larger than that of the Gastropoda. In all the palæozoic deposits the two lowest organized orders, the *MYTILACEA* and *OSTRACEA*, prevail over the others; but most of the latter are also represented, though the four first ones mentioned in the above table barely by more than a few species. In the mesozoic period, the number of the *LUCINACEA* and *TELLINACEA* distinctly increases; the *CHAMACEA* make probably their first appearance and rapidly diminish again towards the close of it; the *VENERACEA* and *PHOLADEA* also show their first characteristic forms, while the *MYACEA* attain a very large development and decrease from that time very sensibly. The *ARCACEA* appear steadily to increase from the earliest time; the *UNIONACEA* are represented in the palæozoic rocks only by a few species and are sparingly found in the fresh-water deposits of the following formations; the *PHOLADACEA* are rare through all the formation, but are already found in the palæozoics.

In the cainozoic period all the orders are represented, and the geographical distribution of the present time is clearly indicated; in fact this indication is noticeable already during the cretaceous period, as I shall have repeatedly occasion to remark.

Looking at the fauna of the present day, it is scarcely necessary to notice that by far the larger number of Pelecypoda is found in the tropical seas. Most of the species live in the so-called Laminarian zone, many are also characteristic littoral types, and various species are met with from low water to the greatest depth (6—800 fathoms) in which Mollusca have been discovered. Special localities, characterized by certain orographical conditions and climate, have, as usually, their peculiar faunas. There are only few species which have a general distribution, and for these (as in the case of many *PHOLADIDÆ*) special reasons exist. I will give greater details regarding the distribution of the various genera, &c., when treating specially of each family.

I. Order. **PHOLADACEA.**

This order includes burrowing Pelecypoda, provided with a small foot, and with long united siphons into which the gills are prolonged. The shells are small, covering only the anterior part of the body, while the posterior part often secretes a calcareous tube, lining the cavity made by the animal. The ligament and cartilage, as well as the hinge teeth, are generally obsolete, but sometimes there are present long processes below the hinges for the attachment of muscles. Most of the species burrow in solid objects, in wood and stones, or corals; few in sand.

The families belonging to this order are the *PHOLADIDÆ* (*TEREDININÆ* and *PHOLADINÆ*) and *GASTROCHÆNIDÆ* (*GASTROCHÆNINÆ*, *CLAVAGELLINÆ*, and *BRECHITINÆ*). Geologically, they are sparingly represented in palæozoic strata, their number gradually increasing in the meso- and kainozoic epochs, and they have their maximum of development in the present time, possessing a wide geographical distribution, as regards genera as well as species. The most important monograph of the recent species, belonging to this order, is that of G. Tryon, Junr., in the Proceedings of the Philadelphia Academy of Natural Science. I shall have occasion to refer to this paper frequently.

I. *Family*,—*PHOLADIDÆ*.

Animals club-shaped; the mantle closed anteriorly, provided with a single perforation through which the more or less elongated, fleshy, and muscular foot is protruded; posteriorly the body is prolonged,—sometimes to a considerable extent,—terminating with two more or less distinctly separated siphons. The posterior part of the body is often covered with a shelly tube, while the anterior one is protected by two equal or sub-equal valves, either gaping in front, or closed by a special shelly lamina, and besides often strengthened exteriorly by small variously shaped, accessory valves; from the beaks extend internally towards the periphery one or more processes, which are either free or grown to the valves, and to which the muscles of the foot attach themselves; there are no true hinge teeth present; the pallial sinus is always marked.

Although the Pholads,—probably on account of the difficulty in collecting them,—were for some time rather neglected by conchologists, they have received a good deal of attention within the last few years. Later geological researches have also brought to light a considerable number of fossil forms, so much so that in the last decennium the number of known species has been more than doubled.

It would be superfluous for me to enter here into any lengthened account on the mode of life* of this group of Molluscs. Recent careful studies have sufficiently proved that the enormous destruction which they produce on shipping and submarine wooden-works is effected by a very simple mechanism. In the true

* I may mention on this subject Forbes' and Hanley's History of British Mollusca, Vol. I, p. 57, etc.,—Deshayes' Paris fossils, Vol. I, p. 106, etc., and Fischer's studies on the *PHOLADIDÆ* and *TEREDIDÆ* in the Journal de Conchiliologie of 1857 and 1860.

PHOLADINÆ the boring instruments are the numerous very fine imbrications of the shell, which very probably contain a number of silicious particles; in the *TEREDININÆ* such silicious particles have been shown to occur plentifully imbedded in the superficial muscular tissue of the front part of the body. The turnings of the shells are effected by the foot, which by its shortness and strong muscular structure is well adapted for that purpose. The idea of the secretion of some kind of acid, which alone would produce such excavations in wood and hard rock, has been justly rejected altogether; at the same time it appears very likely that the organic fluid secreted by the body,—being at a certain degree of higher temperature, so to say, infiltrated or injected with force by the animal into the finest pores of the material attacked,—must greatly facilitate the boring, inasmuch as it softens the finest particles of the substance all round.

Species of Pholads have been described already from palæozoic rocks, but they are not sufficiently characterized. Pieces of wood bored by them, (and probably also by *TEREDININÆ*)*, occur in the carboniferous strata. From the jurassic beds several species† from France, England, and Russia are well known, although their generic determinations are not always sufficiently certain. The cretaceous period contains, however, a number of good types, exhibiting in general a great similarity to recent forms. We may say that there are about 40 species known to occur in cretaceous rocks; the somewhat larger number belongs to the *PHOLADINÆ*, the smaller to the *TEREDININÆ*. In the tertiary strata species of *PHOLADIDÆ* occur sparingly, at least the number of them upon record is scarcely larger than that from cretaceous beds. At the present time their geographical distribution is world-wide, and many of the species appear to possess a greater faculty of accommodating themselves to different climatological provinces than other molluscs. The geological history of the family distinctly shows that it has its maximum of development in the present epoch. The great similarity in the general structure of the Pholads seems to have been rather an obstacle towards their detailed knowledge, and there can be little doubt that we may soon see the number of species doubled, when conchologists get more accustomed to see the usefulness of a chisel and hammer, or of a hatchet, as welcome companions on their excursions. Along the shores of the Bay of Bengal I have met with several as yet undescribed species.

Among the most recent and best researches on the *PHOLADIDÆ* are those of G. W. Tryon, Junr., who published a monograph of that family in the Proceedings of the Academy of Natural Sciences, Philadelphia, for 1862, and lately, 1867, a revised catalogue of the same in the American Journal of Conchology, vol. iii, pt. 3. In this last paper Tryon accepts for our shells two family divisions, *PHOLADIDÆ* and *TEREDIDÆ* (*TEREDINIDÆ*). The advantage of such a thorough separation appears to be very doubtful, nor does there seem to be sufficient ground for it in the organisation, or in the habits of the animals or shells. The character of the organisation is throughout the family the same: a wormlike body

* *Teredo antiqua*, M'Coy, from the carboniferous strata, and others.

† See Morris and Lycett: Mollusca of the Great Oolite,—Buvignier: Statistique de la Meuse.

with a short foot in front, and posteriorly prolonged into two fleshy siphons, separated at, or towards, their terminations. The length of the siphons, and naturally also of the gills, even varies in different individuals of the same species, living in distinct localities. The brittle structure of the shell is entirely the same in the various genera, as also its peculiar imbrications and their arrangement on the outer surface. The presence or absence of a shelly tube does not seem to be of any great importance, because it entirely depends upon the circumstances under which the animal lives, whether it does, or does not, secrete a solid tube at all; and its thickness varies a great deal in different specimens of the same species. I have myself observed species of *TEREDININÆ* (*Nausitoria* and *Kuphus*), in which in some places no shelly tube was secreted, although the surrounding wood was in such cases always impregnated with mineral substance. The palettes protecting the terminations of the siphons and the so-called accessory valves on the shell itself are the only characters which appear to be of any importance in point of classification, and based upon these we retain here the older separation of the family into *TEREDININÆ* and *PHOLADINÆ*. In the former the shape of the palettes has been suggested as the base of generic distinction, and in the latter that of the accessory valves.

a. *Sub-family*,—*TEREDININÆ*.

(*TEREDININÆ* and *KUPHINÆ*, or *FURCELLINÆ*, *auctorum*).

Animal secreting a shelly tube, generally closed in front, open behind, the siphons protected by a pair of shelly or horny styles. Shell sub-globular, widely gaping in front, each valve marked externally by a furrow running from the umbones towards the periphery; accessory valves are wanting, but the umbonal muscles are usually covered by a coriaceous ligament;—boring generally in wood.

The animals which are included in this sub-family have been separated by Bronn into two families, *TEREDINANA* and *FURCELLANA* (Klassen and Ordnung. d. Thierreiches, vol. iii, p. 476). The distinction is based upon the supposed fact that the animal of *Kuphus* (or *Furcella*) *arenarius* does not possess shelly valves, but merely secretes a shelly tube, closed in front by two partially overlapping lamellæ. Tryon, in his Monograph of the *PHOLADIDÆ*, proposed on the same ground a distinct sub-family under the name of *KUPHINÆ*; H. and A. Adams in their "Genera of rec. Moll." ii, p. 332, class *K. arenarius*, (*Teredo gigantea* of Linnæus,) in the genus *Teredo*, simply noting "that the apex of the tube is divided at the end by a longitudinal septum, and is produced into two separate tubes." This evidently applies to the posterior or siphonal end. No mention is made of the existence or the want of valves, which should distinguish the species from *Teredo* proper. Deshayes in his first volume of the *Traité élément. de Conch.*, vol. i, pp. 40-47, describes with some detail *Kuphus* under the Lamarckian name of *Septaria*. He states that the shelly tube is open in front.

In *Kuph. arenarius* no shell is known to exist, but Deshayes notices, as a second species of the same genus, the *Sept. Mediterranea* of Matheron, which has subsequently been stated to be identical with *Teredo norvegica*. Of the first species the same author says that it only differs from *Teredo* by living in sand and not in wood. There are two small valves present and two palettes as in *Teredo*. The question as to the real character of *S. Mediterranea* and Guettard's genus *Kuphus* appears, therefore, still unsettled. Deshayes in his last edition of the Paris fossils (1860, vol. i, p. 107,) gives a list of the genera of the *PHOLADIDÆ*, but on this occasion he omits the name *Septaria* altogether, which tends to prove that he considers it to be identical with *Teredo*.

Wright in his recent paper on the *TEREDIDÆ* (Trans. Lin. Soc., Lond., vol. xxv, p. 563), quotes the authority of Sir E. Home in support of the statement, that in the tube of *Kuphus arenarius* "both valves and palettes, have been discovered." The palettes of *Kuphus arenarius* Dr. Wright found to be very similarly formed to those of a species which he obtained from Singapore, and which he described under the name of *Kuphus? Mannii*; it has a shell like *Teredo*. A very similar, or probably the same, species as the last also occurs about Calcutta in the Gangetic Delta, and I can confirm Dr. Wright's account in this respect. Besides this I also obtained here perfect specimens of one or two species of *Nausitoria*, a *Xylotrya*, and I hope also to procure good specimens of *Calobates*. Some interesting points as regards the anatomy of these animals I trust to be able to publish shortly.

A question, which it is desirable should be settled as regards the species *Kuphus arenarius*, is, whether it really possesses valves similar to those of *Teredo*, or whether it has none. Judging from the species described by Wright as *Kuph.? Mannii*, Sir E. Home's statement regarding *K. arenarius* is, I believe, very probably correct, and in such a case the necessity for a special sub-family ceases.

The fossil genus *Teredina* will be noticed among the *PHOLADINÆ*; thus we shall retain in the sub-family *TEREDININÆ* only those forms which are generally known under the ancient name of *Teredo*. Subsequent discoveries seem, however, to make a sub-division of this old generic group very desirable, and, as already noticed, the form and structure of the palettes, or styles, has been suggested as the base of distinction. Objections have been raised against this, stating that no generic importance can be attached to these palettes. It is really difficult to form a very correct idea on this point. For my own part I do not consider it satisfactory, but it is certain that the known species can be, — to some extent at least, — grouped according to the form of their palettes, and, whether we call these groups genera or sub-genera, is, as the greater number of naturalists will admit, of minor importance. In cases like this the most convenient mode ought to be adopted. The palettes protect the siphons, which are a very important part in the organisation of the animal, and any changes made in the latter will probably produce a difference in the former; thus they are in close connection with each other. The valves in the *TEREDININÆ* are always of the same kind, and, as already noticed, sometimes not to be distinguished

from those of the *PHOLADINÆ*. Each valve has a distinct anterior auricle, while the posterior is usually also separated from the central body by a special groove. This body, or the middle area of the valve, is itself again often divided by a median ridge into an anterior (generally smaller) and a posterior area, the imbrication on both converging towards the central ridge running from the apex to the periphery, and here, in the middle of the ventral region, usually terminating with a small solid boss. The form of the valves greatly varies with the age of the specimens, the shells having, when young, the umbones perfect, while with progressive growth the entire upper portions of the shell become more or less corroded. In the same way the front portion of the anterior auricle is liable to great changes, being an essential part of the shell employed in the boring operations of the animal. In the form of the tubes there are also numerous variations to be observed. It is evident that, when the anterior end of the tube is closed, the animal can only effect its progress in boring when it has dissolved the frontal diaphragm; this must lead us to suppose that the *Teredos* bore only at certain times of the year, while at other times (? the breeding or hatching season) they are at rest, the tube being closed anteriorly.

The following are the principal generic groups, as partially suggested by Dr. Wright:—

1. *Teredo*, Sell., 1732. Palettes testaceous, single, oblong, usually truncate at the end; tubes long, gradually increasing (*T. norvegica*, Spengl.).

2. *Uperotis*, Guett., 1774. Palettes testaceous, spoon-shaped, depressed; tubes short, club-shaped (*U. clava*, Gmel.).

3. *Kuphus*, Guett., 1774. Palettes testaceous, club-shaped, with the ends expanded and truncated, spatulate, (*Kuph. Mannii*, Wright).

4. *Calobates*, Gould, 1862. Palettes dilated towards the middle, with a narrower spoon-shaped and long process at the end; the basal prolongations of the palettes are bony, (*C. thoracites*, Gould).

5. *Nausitoria*, Wright, 1864. Palettes testaceous, solid, elongated and pyramidal, flattened inside, transversally imbricated on the outer convex surface, (*N. Dunlopii*, Wright).

6. *Xylotrya*, Leach, 1840, (teste, Gray). Palettes very long, more or less bony or horny, with lateral flexible serrations or setæ, (*X. bipinnata*, Turt.).

? 7. *Teredolites*, Desh., 1842, (Mem. Soc. Géol. de la France, vol. v, p. 2). This was proposed by Deshayes for a cretaceous species, *T. clavatus*, known only by some tubes which are short, clavate, and in position, as they occur in the rock or wood, almost parallel to each other. Deshayes does not take any notice of this supposed new generic type in his subsequent revisions of the *PHOLADIDÆ*, but the form of the tubes is certainly very peculiar, and it is very likely that the animals were somewhat different from those of *Teredo*. *Martesia* and *Parapholas* bore in wood in a way very similar to this fossil form, which ought to be carefully compared with them.

8. *Polarthus*, Gabb, (*vide* Check-list of the Invertebrate foss. of North America; Smithson. Misc. Coll., No. 177, p. 16, 1864). This has been based upon a cretaceous species, *P. americanus*, from New Jersey, but I have not been able to get access to any detailed statement regarding the distinctive characters of the genus.

It does not appear quite certain whether the distinctions pointed out as existing in the shape of the palettes of the first three genera are sufficient to warrant the above-mentioned divisions; they may all be considered as slight variations of one and the same genus, *Teredo*, but of the three other groups the palettes seem to be sufficiently distinct, though, no doubt, passages from one into the other,—as, for instance, between *Nausitoria* and *Xylotrya*—, may readily be observed.

Tryon (Am. Journ. Conch., vol. iii, pt. 3, 1867,) enumerates 31 recent species of *TEREDININÆ*. From tertiary deposits about 15 species are known, and from the cretaceous* Pictet (Mat. p. l. Paléont. Suisse, 4^{me} Ser.; Foss. St. Croix, 3^{me} part., No. 1, p. 21, &c.) quotes seven European species; *T. Argonensis*, *Varenkensis*, *bilobatus*, *Fleuriaus*, *Requienianus*, *Deshayesi* and *rotundatus*; several of them are, however, very unsatisfactorily recorded. Coquand described a *Ter. lignitorum* from the étage Aptien of Spain (Mon. de l'Aptien, etc., 1865, p. 87). Schafhäutl in his Süd-Bayern's Leth. Geognostica, 1863, (pp. 177 and 178) names two tubes, *Teredo* (*Gastrochæna*) *ornata* and *rugosa*, respectively; as he identifies other fossils, apparently occurring in the same beds as these two, with known cretaceous species, one must suppose that the former are also cretaceous; no distinct proof, however, is given of their geological position.

Eichwald in his Leth. Rossica, livr. xi, 1867, (p. 792, etc.) describes under the generic name of *Teredo* six species which, he states, all occur in cretaceous deposits. Of none of them have the valves been noticed, and the tubes of some appear rather defective. *Teredo Tournali* is identified with a species described by Leymerie from supposed nummulitic beds. *T. Argonensis*, Buv., is determined from a small tube which does not very well agree with Buvignier's and d'Orbigny's figures. The others are new, *T. sulcata*, *lignicola*, *conulus*, and *socialis*. Of the first the representation may be taken rather for that of a *Gastrochæna* than of a *Teredo*. The tubes of the two last named, and especially that of *T. conulus*, greatly resemble in general form the short tubes described by Deshayes as *Teredolites clavatus*. It is quite possible,—if not more probable,—that these tubes were made by shells of the *PHOLADINÆ*, or by a *Gastrochæna*, for they occur socially, often in great numbers, and bored for only a short distance into the wood, as the *Martesia*, &c., generally do at the present time; but they are somewhat thickened and blunt at the anterior end, a form more usually occurring in the *TEREDININÆ* than in the *PHOLADINÆ*, though not quite foreign to the latter. Zittel in his Monograph of the Pelecypoda (Bivalves) of the Alpine Gosau-formation (Denksch. Acad., Wien, 1865, vol. xxiv,) does not describe any species of *PHOLADIDÆ*. As far as I remember, vegetable remains, bored by them, were repeatedly found in the coal beds of the so-called "Neue-Welt" near Wiener Neustadt, and we may expect some additions to the cretaceous fauna from this quarter.

The fragment of a tube figured by Römer (Nord-deutsches Kreidegeb., pl. 10, fig. 9,) as *T. dentatus* is much like that of a tube of a *Teredina*, while the Maastricht *Teredo Faujasi* of Bronn seems more likely to be a serpuloid shell than a *Teredo*; numerous fragments of wood, however, occur in the Maastricht beds, entirely bored by true *TEREDININÆ*. The tubes so commonly known from the German cretaceous deposits as *Gastrochæna* (or *Serpula*) *amphisbæna*, Goldf., are most likely those of a species of *Teredo* or *Teredina*; they are much too long for a *Gastrochæna*, and also too regularly

* *Teredo Argonensis*, Buvignier, is probably a *Turnus*, which genus may also belong to this sub-family.

tubular. The same is most likely the case with Müller's *Gast. voracissima* from the cretaceous beds near Aachen.

Meek in his Check-list of cretaceous fossils of North America (Smithson. Miscell. Coll., No. 177, p. 16,) quotes six species of *Teredo*,— *T. calamitoides*, *contorta*, *globosa*, *irregularis*, *selliformis*, *tibialis*,— and the previously mentioned *Polarthus americanus*.

I have to record from South India four new species of *TEREDININÆ* which, so long as the palettes are unknown, may be described under the generic name of *Teredo*; this will raise the total number of cretaceous species to about 26, though hardly more than one-half of them are sufficiently certain as belonging to the sub-family; in no instance are the palettes satisfactorily known.

I.* *TEREDO*, *Sellius*, 1732.

1. *TEREDO PARTITA*, *Stoliczka*, Pl. I, Fig. 1.

T. testa globosa, æqualiter lata quam alta, striis ad medium convergentibus subtilissimis ornata; umbonibus distinctis, incurvatis; auricula anteriori magna, subangulata, supra ad marginem incrassata; hiatu anteriori mediocri, fere triangulari; auricula postica angustata, ab corpore testæ sulco profundo separata. Tubula cylindracea, in junioribus varie torta, crassiuscula, in adultis sub-recta, transversaliter crasse ac numerose rugata, intus costa mediana ventrali, tenui ac rectiuscula instructa.

The sub-cylindrical form and the numerous transverse rugations appear to be characteristic for this species. The young shells are, as usually in living forms, found boring in all directions through the wood; they are considerably thickened at the anterior end, but otherwise of much the same thickness throughout. The tubes of older specimens are placed parallel to the fibre of the wood; the cast exhibits a distinct furrow on the ventral side of the tube, corresponding to the lower thickened terminations of the valves. Such a furrow is often to be seen on living specimens of *Teredos*, and is produced by a slight rib on the internal side of the tube. The two valves, when closed, are almost perfectly globular, the striations on the outer surface being extremely fine, so much so that they are often hardly traceable. The anterior auricle is comparatively large, occupying nearly half the height of the shell; it is anteriorly sub-angular, and on the upper side in front of the beaks rather strongly thickened; its margins are sharpened and bent externally; the furrow separating it from the body of the valve is quite indistinct, and the one in the middle of the shell, where the striæ of the surface converge, is only traceable towards the ventral terminations; the cast is quite smooth. The anterior hiatus is broadly triangular, laterally slightly angular; the posterior larger and sub-ovate. The posterior auricles are very narrow, separated from the central area of the shell by a deep groove.

Locality.—Found boring in fossil-wood at Ootatoor and at Moraviatoor.

Formation.—Ootatoor group.

* I shall again,—as in the second volume, treating on the Gastropoda of the South Indian cretaceous rocks,—adopt the plan of numbering the genera consecutively throughout the whole class *Pelecypoda*, and give separate numbers to the species under each genus.

2. TEREDO CRASSULA, *Stoliczka*, Pl. I, Fig. 2.

T. testa globulosa; umbonibus prominentibus, incurvatis; valvis in areis medianis subtile arcuatim striatis; auricula anteriori sublævigata, parva; posteriori magna, postice rotundata, ejusdem margine superiori recto. Tubulis sublævigatis, crassis, irregulariter tortis, subcylindræis, antice clausis, leviter rotundatis sed non tumescentibus.

The tubes of this species are in proportion thicker than those of the previous one, and are generally slightly bent or undulating; their surface appears to be nearly smooth. The anterior end of the tubes is not thickened, but gradually rounded and closed.

The shells are nearly globular, perhaps a trifle higher than thick; the outer surface of the median area is covered with very fine angularly bent striæ, and two fine grooves run along the greatest convexity from near the apex to the periphery. The anterior auricle is rather small and the striæ on it minute; the posterior comparatively large with a straight upper margin, and with the striæ also much finer than in the centre of the valves.

Locality.—In fossil wood, impregnated with calcareous matter, at Ootatoor.

Formation.—Ootatoor group.

3. TEREDO TORULOSA, *Stoliczka*, Pl. I, Fig. 3.

T. testa transversaliter ovata, inflata; umbonibus incurvatis; hiatu antico magno, late triangulari, postico sub-elliptico, angustato; auricula antica moderata, triangulari, substriata; area centrali magna, linea impressa angustissima ab umbonibus ad peripheriam oblique decurrente divisa, subtilissime arcuatim striata; auricula postica angusta, sulco lato ab area centrali separata, subrugosa. Tubulis cylindræis, tenuibus, varie tortis, transversaliter minute rugatis; terminationibus anticis clausis, clavatis ac plus minusve inflatis.

The form of the tubes of this species greatly resembles that of *Teredo Argonensis*, being thin, sub-cylindrical, and with the anterior ends somewhat inflated. These inflated or clavate anterior terminations are among the recent *TEREDININÆ* more commonly observed in *Kuphus* than in *Teredo* proper. The valves are in proportion to their size rather oval, on the surface very minutely striated; the anterior auricle is of moderate size, the posterior one narrow, slightly rugose and separated from the central area by a shallow but broad groove which runs from under the umbones towards the posterior margin. The position of this groove, as well as the much less distinct one on the central area, and the fine striation readily distinguish this species from *T. Argonensis*.

Locality.—Moraviatoor, found boring in wood with *Martesia tundens* and *Parapholas mersa*.

Formation.—Ootatoor group.

4. TEREDO (UPEROTES?) GLOMERANS, *Stoliczka*, Pl. I, Figs. 4-5. ✓

T. (Uperot.) tubulis varie tortis, sæpe acglomeratis, lævigatis, tenuibus, terminationibus anticis clausis, vix inflatis, subtruncatis. Valvulis testæ ignotis.

This species is based upon two tubes found in a coarse, conglomeratic sandstone. They are variously contorted, and one of them (of which a representation is given in figure 4 on plate I) is extremely like some of the tubes of the recent *Uperotes clava*, which generally bores in cocoanuts, or in floating pieces of wood. The tubes are rather thin, smooth on the surface, with occasional projecting laminæ on the turns or bendings; they are sub-truncated anteriorly and closed, but not particularly enlarged. No shell has been observed, nor any division or concameration at the posterior end, such as often occurs in true *Teredo* or in *Kuphus*.

Locality.—Comarapolliam, in a greyish coarse sandstone.

Formation.—Arrialoor group.

b. *Sub-family*,—*PHOLADINÆ*.

The animals of the *PHOLADINÆ* resemble in general structure those of the *TEREDININÆ*, but they never grow to the same great length; consequently the gills are shorter in the former. The greater part of the body is covered with the shell, formed by the two ordinary, or several other accessory, valves; the mantle is cleft in front to admit of protruding a small foot. The siphons are united nearly up to the end, and do not, as a rule, secrete any palettes. A great peculiarity of most of the *PHOLADINÆ* is the reflection of one part of the anterior adductor muscle towards the beaks, often forming here a more or less cellular secretion, and in some way replacing the ligament. This last is generally absent; only in a few instances rudiments of it were observed.

The shell is, as I have already noticed, formed in all the *PHOLADINÆ* on the same principle. The valves generally are equal, inequilateral, with an internal apophysis under the beaks, without hinge teeth, more or less gaping in front, and on the surface with variously arranged imbrications which are sharpest on the front part of the valves. An important character of a large number of the shells of *PHOLADINÆ* is the presence of the above-mentioned shelly reflection of the antero-superior margin of the valves upon the beaks, covering these partially or totally. A still more important distinction of this sub-family from the former is the presence of accessory valves* in almost all *PHOLADINÆ*. The arrangement, form, and position of these valves has been selected as the principal basis for generic distinctions in the same manner as the palettes in the *TEREDININÆ*. They are no doubt of great importance, for their chief object appears to be to give the two large valves a certain fixed position during the act of boring, when they could easily be dislodged; but because these supplementary valves are in constant use their form is greatly variable,

* Leach introduced a special nomenclature for these valves as regards their position. They may be called *umbonic*, *pre- or post-umbonic*, *antero-superior*, *antero-inferior*, *anterior* and *posterior*, *ventral* and *siphonal*; the signification of these terms does not require any further explanation.

and their number sometimes changes at different stages of growth in one and the same species.

Omitting the indistinct traces in palæozoic formations, true *PHOLADINÆ* are with sufficient certainty known from the jurassic period, and during the cretaceous time they were already tolerably numerous, though unfortunately often not so perfect as would be required for a correct generic determination. The tertiary period supplies a large number of characteristic forms; these are in general very much like the recent ones.

The *PHOLADINÆ* bore in wood, all kinds of rock, sand, mud, and in other shells, or corals; their borings are not usually very deep, and the hollows only occasionally entirely or partially lined with a shelly tube. In the fossil *Teredina* the tube is grown together with the valves, as in the *GASTROCHÆNIDÆ*. Tryon (Proceed. Acad. Nat. Sc., Phil., 1862), in retaining the *PHOLADINÆ* as a family, proposes to separate it into true *PHOLADINÆ* and *JOUANNETINÆ*, the former having the anterior hiatus always open, the latter closed when adult. In some respects the division may be deemed convenient, but it cannot be considered as of any great importance, because the case generally depends merely upon the stage of growth whether the animal closes its shell in front or not.

The following is a summary of the genera as at present known. I shall enumerate them according to their relations to the *TEREDININÆ*, showing gradually, by a decrease of the accessory valves, the general form of their shells, &c., a passage to the *GASTROCHÆNIDÆ*.

1. *Teredina*, Desh., 1824. Valves *Teredo*-like, but firmly connected with the tube, one small accessory valve covering the umbones and extending anteriorly, another large accessory valve occupying the whole of the front of the valves and extending below. Deshayes in his last edition of the Paris fossils, (1860, vol. i, p. 124, etc.,) described under this genus three species, *T. personata*, Lamk., *T. Oweni* and *Heberti*, Desh.

The presence of accessory palettes designate this genus as one of the *PHOLADINÆ*, especially as no siphonal palettes seem to exist, although the usual bifid terminations of the tube are very much like those of *Kuphus*, and are no doubt an important character of the *TEREDININÆ*. It would probably be best to constitute a special sub-family for this genus, but it will only have its full value when the existence or non-existence of palettes is sufficiently ascertained. The termination of a tube figured by Römer under the name of *T. dentatus*, (Nord-deutsch. Kreidegeb., 1841, pl. 10, fig. 9,) is, as already pointed out by Pictet (Pal. Suisse, 3^{me} Ser., 3^{me} part., p. 23, 1864), quite as likely a *Teredina*. Römer's *Teredina clavata* (ibid, pl. 10, fig. 10), from the Sénonien near Quedlinburg, the same author, as well as Geinitz and others, believe to belong to *Clavagella*, or to an allied genus. The specimen described and figured is, however, quite insufficient to warrant an idea as to the exact generic characters of the fossil.

Römer's *Fistulana constricta* (ibid, p. 76, pl. 10, fig. 2), which he identifies with Phillip's *Phol. (Martesia?) constricta*, (Yorksh., pt. i, pl. 2, fig. 17,) and which

has also been supposed to belong to *Teredina*, is more likely a *Pholadidea* or a *Martesia*; it will be noticed subsequently under the name of *Ph. Römeri*.

2. *Xylophaga*, Turton, 1822. Valves *Teredo*-like, semi-oval, strongly gaping in front, less so behind; each valve with an internal rib running from the apex to the periphery; two pre-umbonal accessory valves present.

Three recent and a few tertiary species of this genus are upon record. Two species were formerly described under this genus from the cretaceous rocks of North America, but for each of these distinct generic denominations have lately been introduced.

3. *Gonioclasma*, Meek, 1864, (Smith. Misc. Coll., No. 177, p. 34). The type is *Xyloph. Stimpsoni*, Meek and Hayden; it is said to differ from *Martesia* by the want of accessory "pieces" (valves?), and in having the anterior hiatus formed by a rectangular notch in the antero-ventral margin of each valve.

4. *Turnus*, Gabb, 1864, (Palæont. of California, vol. i, p. 145). The shell is like that of *Xylophaga*, but has posterior to the internal umbonal rib another, often broader rib, running from behind the apex towards the infero-posterior margin. The animal also secretes a shelly tube, and consequently the valves must have been much more gaping posteriorly than they are in the recent *Xylophagæ*, which only slightly protrude out of their shells. The accessory valves are unknown, and it is therefore difficult to classify exactly the genus, for it may be just as possible,—and I would almost consider it more probable,—that it is a form of the *TEREDININÆ*. Gabb describes one cretaceous species (loc. cit., p. 146, pl. 22, fig. 116), *T. plenus*, and I shall have to notice a second species of the same genus from our Southern Indian cretaceous rocks, *T. lapidarius*, n. sp. *Teredo Argonensis*, Buvignier, may be a third species of this genus, and as regards the form of the shell itself it closely resembles the last named one. Eichwald in his *Lethæa Ross.*, (livr. xi, 1867, p. 790, pl. 22, fig. 13,) states that *Pholas Waldheimii*, d'Orb., occurs in the Neocomien at Khoroschówo near Moscow; the species secretes a solid shelly tube, and has on its valves two ribs running from the apex to the periphery, like *Turnus*, but the anterior portion of the shell would appear to show a great resemblance to a *Martesia*; it may be a *Parapholas*.

4a. The genus *Xylophagella* was proposed by Meek in 1864 (Smith. Misc. Coll., No. 177, p. 34,) for *Xylophaga elegantula* of Meek and Hayden, which is said to differ from *Xylophaga* by the presence of a "postero-dorsal ridge;" I presume, therefore, that it is very closely allied to or generically identical with *Turnus*, but Meek adds, that it "burrows apparently always without a shelly lining." This would be a slight distinction from *Turnus*, but it requires confirmation, though I must say that it does not seem advisable to attach too much importance to the presence or want of a shelly tube. Many other *PHOLADINÆ* give a proof of this, secreting a perfect tube whenever they find a special necessity for it; in other cases they line the hollow excavated by them, only with a very thin shelly layer, and again in others they secrete it only partially, for instance, on each turn of the tube.

5. *Jouannetia*, Desh., 1828, (H. and A. Adams, Gen. ii, p. 329). Shell more or less globose, sculptured as in *Xylophaga*, inequivalve, front gape closed in the adult state; a single accessory valve is present. Besides a few recent species there are some very similar forms known from the tertiary beds, and I shall allude to one or two from the cretaceous strata.

5a. *Pholadopsis*, Conrad, 1849, (Proc. Phil. Acad., p. 156, &c.) is stated to differ from the last in having a "subcentral, radiating" groove.

6. *Martesia*, Leach, 1824 (H. and A. Adams, Gen. ii, p. 330). Shell generally elongately ovate, posteriorly produced, equivalve; anterior hiatus closed; one umbonic accessory valve; one narrow stilet-like post-umbonic plate, and a similar postero-ventral one; valves sculptured similarly to those of *Xylophaga*.

This genus is well known from cretaceous as well as from tertiary deposits.

6a. *Pholameria*, Conrad, 1865, (American Journ. Conch., i, p. 2), has been proposed for an oligocene species, described in Journ. Acad. Nat. Sc., Phil., 2nd Ser., i, p. 127, pl. 13, fig. 3, under the name of *Pholas triquetra*. The shell has the form of a short *Martesia*, but without accessory plates; nothing else, however, occurs in the specific description which would indicate any peculiarity to justify the formation of a new genus.

7. *Schröteria*, Tryon, 1862 (Proc. Phil. Acad., 1862,) has one pre-umbonic plate; the anterior hiatus is probably closed in the adult shell; the type is *Pholas cordata*, Schröter.

8. *Diplothyra*, Tryon, 1862, (ibid). Shell like in *Martesia*, but with one larger umbonic and one smaller pre-umbonic accessory valve. Stimpson (American Journ., XXXV, 1863, p. 306,) states that the species described by Tryon as *D. Smithii* is a true *Martesia*.

9. *Parapholas*, Conrad, 1848, (Proc. Acad. Nat. Sc., Phil., p. 121). Shell ovately elongated like *Martesia*, equivalve, sculptured at the sides similarly as in *Xylophaga*; anterior hiatus closed; umbonal accessory valve longitudinally divided in two, often extending backwards; superior margin in front of the umbones reflexed; median area generally with two transverse furrows from the umbones.

The forms called *Parapholas* are very closely allied to those of *Martesia*, and they could probably be considered merely as sub-generic to the latter genus. The division of the umbonal plate does not seem to be always perfect, as I shall have occasion to notice subsequently when describing a cretaceous species, *Paraph. mersa*. However, there is a peculiar distinctive character to be noticed in a few of the Indian species which in external form and in the two sulci on the median area of the shell perfectly agree with Conrad's *Parapholas*, except that their umbonal valves are short and broad. I refer here specially to three forms which I have examined: *Martesia fluminis*, Blf., (Jour. Asiat. Soc., Bengal, 1867, vol. xxxvi, p. 67, pl. 3, figs. 1-3,—or a very closely allied species); a new species apparently with the anterior hiatus permanently open, and boring in wood along the mouths of rivers of the Orissa coast, and a third (typical) species from Ceylon. All these have in the left valves a distinct claw-shaped tooth, and an obsolete tooth in the

opposite valves. Above these teeth there is a small cartilage lodged. I have seen only large specimens of Conrad's type *Parapholas Californicus*, and these do not show any teeth, but a cartilage below the beaks; the shells of the *PHOLADINÆ* change, however, so much with age, that I could not feel certain in proposing a new generic name for our shells unless I had the opportunity of examining young and fresh specimens of the above-mentioned type species.

10. *Pholadidea*, Turton, 1819, (H. and A. Adams, Gen. ii, p. 328). Shell very similar to *Martesia*, the two dorsal accessory valves are smaller than in *Parapholas*; the posterior end is enlarged into a cup-shaped appendage protecting the siphons.

Tryon in his last review of the *PHOLADIDÆ* in American Journ. of Conch. (vol. iii, 1867, part 3), quotes the following sub-genera of this genus; *Hatasia*, Gray, *Talonella*, Gray, *Netastomella*, Carpenter. The differences of these from the type genus appear to be of little importance. I shall only refer to the last one; of the first *Ph. melanura*, Sow., of the second *Ph. tridens*, Sow., are considered as types.

10a. *Netastomella*, Carpenter, 1865, (Proc. Zool. Soc., p. 202,) is based upon *Pholas Darwinii*, Sow., the valves of which are posteriorly prolonged into a flattened calcareous cup. It is said to differ from *Jouannetia* in having both valves equal, and from *Pholadidea* by the calcareous nature of the cup at the posterior end of the shell.

11. *Penitella*, Valenc., 18?? (Conrad, 1849,— see Tryon's Memoir on the *PHOLADIDÆ* in Proc. Phil. Acad. for 1862). Shell very similar to that of the previous genus, slightly expanded posteriorly; one umbonal and two pre-umbonal accessory valves, placed side by side, are present.

12. *Talona*, Gray, 1840, (H. and A. Adams, Gen. ii, p. 329). Shell in form resembling *Pholadidea*; anterior hiatus open, very small; pre-umbonal margins of the valves reflexed; two small umbonal plates side by side; posterior end enlarged, cup-shaped, and protected by a pair of siphonal valves.

13. *Navea*, Gray, 1851, (ibid., p. 328). Shell small, sub-ovate; one small post-umbonal accessory plate; anterior hiatus widely open.

14. *Barnea*, Leach, 1826, (ibid., p. 326). Shell elongately ovate; one narrow and long umbonal accessory plate; umbonal processes thin, reflexed. There are two slightly different types of shells referred to this genus by Tryon. The one kind, like *B. candida*, L., has the margins of the valves rounded, and the anterior hiatus is long and narrow; these shells are considered to be typical *Barneæ*.

14a. The other form, represented by *B. parva*, L., has the antero-ventral margin insinuated, and the anterior hiatus is short and wide. For this last the sub-generic name *Anchomasa*, Leach, has been adopted.

14b. *Monothyra*, Tryon, 1862, (Proc. Phil. Acad.) may be considered as a third form of the same general type; it only differs from typical *Barnea* by having the umbonal plate larger, cuneiform, and the umbonal processes cellular. *Pholas*

orientalis, Gmel., is the type of this genus which certainly is closely allied to *Barnea* and has, I believe, only sub-generic value.

15. *Pholas*,* Linné, 1757, (H. and A. Adams, Gen. ii, p. 325). Shell elongated, one umbonal accessory plate, extending forward, and one small post-umbonal; hinge plate reflexed over the beaks and closely applied.

Klein used the name *Pholas* correctly, but his figure of the type species is not clear.

15a. Tryon separates the species with a wide emarginated anterior hiatus (like *Ph. crucifera*, Sow.) into a distinct sub-genus, which he calls *Cyrtopleura* (1862).

16. *Dactilina*, Gray, 1847, (H. and A. Adams, Gen. ii, p. 325,) differs from *Pholas* in having two accessory, umbonal valves placed side by side; the hinge plate is cellular beneath, reflexed over the beaks.

The typical species of *Dactilina* are those with a short emarginated hiatus in front, like *D. datylus*.

16a. Another group with entire margins of the valves along the anterior hiatus, with the nuclei of the dorsal valves placed anteriorly, like *D. Campechensis* of Gmelin, Tryon considers as a separate sub-genus, and names it *Gitocentrum* (1862).

17. *Zirphæa*, Leach, 1847, (H. and A. Adams, Gen. ii, p. 327). Shell oval, without accessory valves, hinge plate not reflexed, the umbonal muscle only covered with a horny epidermis, anterior hiatus always open. Through the want of accessory valves *Zirphæa* no doubt forms a passage to the *GASTROCHÆNIDÆ*.

The first reliable records of fossil species of *PHOLADINÆ* are from the lower mesozoic strata, (triassic and jurassic), though, as I have already noticed, traces of their borings in fossil-wood and in stone have been found already in carboniferous beds, and some of these hollows most likely have been excavated by molluscs belonging to this sub-family. In the cretaceous strata we find a number of forms which in their general character much resemble the recent species, and this resemblance becomes still more apparent in the forms found in the tertiary beds. Several of the miocene species, like *Teredo Norvegica* or *Xylophaga dorsalis*, are, for instance, not distinguishable from those still found living. Tryon enumerated (in 1867) 63 recent species of *PHOLADINÆ*.

Pictet (Mat. Pal. Suisse, 3^{me} part., 1864, p. 26, etc.) gave a list of the cretaceous species of *Pholas*, taking the signification of the genus in the old sense. He enumerates the following European species:—

1.—*Ph. icaunensis*, Cott.

2.—*Ph. Roemeri*, d'Orb., 1850, (Prod. II, p. 72, *Fistulana constricta*, Römer), has the form of a *Pholadidea*, or a *Parapholas*; the posterior end is not sufficiently attenuated for a *Martesia*. Dr. J. Müller in his Suppl. to the "Monograph. d. Petr. der Aachner Kreidef.," (1859, p. 16,) also proposes for Römer's *F. constricta* the name *Ph. Roemeri*, which d'Orbigny had anticipated.

3.—*Ph. prisca*, Sow., is evidently a *Martesia*, boring in wood.

* *Leuconyx*, H. and A. Adams, is based upon the internal spathulæ of *Pholas costata*, (see Proc. Zool. Soc., Lond., for 1865, p. 754).

4.—*Ph. Cornueliana*, d'Orb., is very likely also a *Martesia*, and the same must be said of the three following species—

5-7.—*Ph. constricta*, Phil., *Ph. subcylindrica*, d'Orb., and *Ph. Rhodani*, Pict.

8.—*Ph. Sanctæ-crucis*, Pictet, may be a *Parapholas*, with two middle furrows.

9-11.—Ryckholt in his "Mélanges paléont." (I. pt., 1852, pp. 114-117,) describes from the upper cretaceous beds of Belgium three species, *Ph. supracretacea*, *Nystiana*, and *Kickxiana*. The first one may be a species of *Jouannetia*, and the last is said to differ slightly from it. *Ph. Nystiana* has very much the form and character of the sub-generic type *Anchomasa* of the genus *Barnea* (see antea p. 21).

12.—An interesting new species, *Ph. reticulata*, was described by Müller (Suppl. Petr. Aachner Kreidef., 1859, p. 15, pl. 7, fig. 17,) from the Sénonien beds of Aachen; it has the general form of a *Martesia*.

13.—*Pholas Waldheimii*, d'Orb., I have already noticed when speaking of the genus *Turnus*, (p. 19).

14-20.—Meek in his Check-list of N. American cretaceous fossils quotes,—beside the three species previously (p. 19) recorded under *Xylophagella*, *Gonioclasma*, and *Turnus*, — *Martesia? cuneata*, Meek and Hayd., *Pholas cithara*, Mort., and *Ph. cretacea*, Gabb, (see Smith. Misc. Coll., No. 177, 1864, p. 16). Gabb in his Palæont. of California, I, p. 145, describes *Martesia clausa* from the cretaceous beds of California.

Ph. sclerotites, Geinitz, (Quadersandsteingebirge 1850, p. 144), can from the present known description scarcely be acknowledged as a species of the *PHOLADIDÆ*. The author quotes it also from the Upper Greensand of England, but does not state the authority for the reference.

There are, including three new species from our Sth. Indian rocks, and excluding several doubtful forms, at the present 23 species of *PHOLADINÆ* known from cretaceous deposits. The Indian species are *Turnus lapidarius*, *Martesia tundens*, and *Parapholas mersa*. Only a few specimens of each of these species have been found, but they do not seem to be rare, though very local. There is great difficulty in extracting the specimens from the fossilised wood, or stone, in a fit state for description.

II. TURNUS, Gabb, 1864, (see p. 19).

1. TURNUS LAPIDARIUS, Stoliczka, Pl. I, Fig. 6.

Tur. testa sub-ovata, inflata, umbonibus anticis, incurvatis, auricula anteriori parva instructa, infra auriculam late hianti, postice subrotundata, fere clausa; costa mediana ab umbonibus ad peripheriam decurrente tenui, sed valde prominenti, altera postica latiorè peripheriam versus fere obsoleta. Tubulis prolongatis, testaceis, tenuibus, clavatis, in superficie transversaliter rugulosis.

The shell of this species is chiefly characterized by the very small anterior auricle, the thin and sharp central rib, and the shallow and broader posterior rib; the latter becomes nearly obsolete towards the periphery. The ventral end of the central area is rounded, not terminating with a thickened boss, as usual in *Teredo*. The tubes are of a thin shelly structure, transversally minutely rugose and increase rather rapidly in thickness. The species was found boring in sandstone without any trace of wood; the tubes seem to be in their original position, not loose, and accidentally buried in the mud.

Locality.—Odium; rare; in yellowish calcareous sandstone.

Formation.—Ootatoor group.

III. MARTESIA, Leach, 1824, (see p. 20).

1. MARTESIA TUNDENS, Stoliczka, Pl. II, Figs. 5-6.

Mart. testa cuneiformi, antice subinflata ac rotundata, posticè attenuata et ad terminationem subtruncata; hiatu antico angusto; superficie in area centrali subtile striata, sulco mediano ab umbonibus decurrente divisa; regione postica lateraliter minute rugosa, area postica supra subcarinata; impressione musculari postica valde elongata; valvula accessa umbonali parva, late ovata, antice emarginata; marginibus valvarum ante umbones elevatis ac reflexis.

The short, anteriorly inflated and globular form of this shell easily distinguishes it from other known species. Young specimens (fig. 5) are more regularly club-shaped, the attenuation of the valves from the front towards the posterior end being more gradual than in old ones. The valves have a distinct, though very narrow opening in front for the protrusion of the foot, the shelly covering being somewhat prominent; the surface of the central area is finely striated, and the striæ pass over the median groove almost continuously; the posterior area is very slightly rugose. The accessory valve covering the umbones is thin and anteriorly emarginated; it is rather broadly oval, but I have not been able to trace exactly its posterior margin.

Locality.—Moraviatoor; boring in wood together with the next species.

Formation.—Ootatoor group.

IV. PARAPHOLAS, Conrad, 1848, (see p. 20).

1. PARAPHOLAS MERSA, Stoliczka, Pl. II, Fig. 7.

Paraph. testa elongata, cuneiformi, antice rotundata, subinflata, postice regulariter attenuata; hiatu antico minimo; superficie lateraliter minute striata, postice supra lamellose rugosa; area centrali duobus sulcis approximatis ab umbonibus ad peripheriam decurrentibus notata; valvulis accessis supra umbones sitis inter se contingentibus, semicircularibus; valvula dorsali postumbonali stiliformi, simplici; ventrali similariter constructa, sed longitudinaliter bipartita.

This is a typical species of *Parapholas*, having the umbonal accessory valve divided longitudinally, but in every other respect the shell resembles a *Martesia*. The two furrows running from the umbones towards the periphery are said to be present in all known species of *Parapholas*; there are, however, some species of *Martesia* known (*M. branchiata*, Gld., and others) which also possess two umbonal valves. On the other hand, there occurs a species in the Irawadi delta, described by Mr. W. Blanford as *Martesia fluminalis*, (Journ. Asiat. Soc., Bengal, vol. xxxvi, 1867, p. 67, pl. 3, figs. 1-3), which has a divided umbonal accessory valve, but only one rib running from the umbones to the periphery, a second one being only internally and not very distinctly marked; it is almost parallel to the superior margins of the valves. Still the species must be considered as a *Parapholas* and not as a *Martesia*, though I must again say that the distinction scarcely deserves to be regarded as of generic value.

The surface of our species is very minutely striated, and the upper posterior margin lamellar. The narrow post-umbonal plate lying between the margins of the valves is stilet-shaped, posteriorly ending in a point; the ventral one is of similar form, but longitudinally divided by a groove. The front edges of the valves below the umbones are slightly elevated, and the region next to them impressed. The species can be easily distinguished by its regular club-shaped form and fine striation on the central area from *Mart. (Parapholas?) sanctæ-crucis*, Pictet; a more closely allied species to ours is the recent *Martesia calva*, Sow.

Locality.—Moraviatoor; boring in wood.

Formation.—Ootatoor group.

II. *Family*,—*GASTROCHÆNIDÆ*.

The animals, belonging to this family, in many respects resemble those of the *PHOLADIDÆ*; they are generally symmetrical, claviform, with a short sub-cylindrical foot which is not byssiferous, although occasionally provided with a byssal groove; the mantle margins are thickened, often prolonged into various cirrhi, or other appendages, united along the ventral side; there are two gills on either side, but their size varies, the outer ones are often larger than the inner; they are more or less prolonged into the siphons, which generally are united up to near their ends. The shell consists of two equal, or very nearly equal valves, which are thin and inequilateral, more or less gaping in front; the hinge teeth are rudimentary or altogether wanting, the beaks being, however, occasionally supported by a small internal lamina; the ligament is external, but usually very small and thin; a portion of it sometimes reaches to the internal edge, representing the cartilage. The valves are either free, enclosed in a shelly tube, or more or less grown together with it. Deshayes in his last edition of the Paris fossils again dwells in great detail upon the idea (which he formerly advocated) of the temporary separation of the valves from the tube during certain stages of growth. The course of growth appears to me not to offer anything peculiar or extraordinary. It is nothing but an organic—may be acid—secretion which constantly dissolves the edges of the aperture in the Gastropoda when they grow largely, and exactly the same takes place at the edges of the valves of *Pelecypoda*.

There are three somewhat different groups of shells which belong to this family. Tryon published a monograph of the family in the Proceedings of the Philadelphia Academy of Natural Science in 1861, and a revised list of the species in 1867, part 3, vol. iii, of the American Journal of Conchology. This last publication is the most complete one available, and in giving here a short review of the various types, I shall follow it with a few slight alterations.

a. *Sub-family*,—*GASTROCHÆNINÆ*.

Both valves lying free in the tube, the living animal covering the former by its mantle, either partially or entirely.

1. *Spengleria*, Tryon, 1861, (vide Proc. Phil. Acad. Nat. Sc.). Valves equal, widely gaping in front and below, generally with a small projection of the margin internally below the umbones; a more or less separated, triangular area runs from the beaks obliquely towards the posterior end; ligament strong; tube claviform.—I consider those forms of *Rocellariæ* (*R. mytiloides*, Lam., and oth.), which Tryon separated under the above (sub-generic) name, as intermediate between the *PHOLADIDÆ* and the *GASTROCHÆNIDÆ*. They have entirely the form of *Rocellaria*, but the process below the beaks is generally somewhat distinct, and there is a line running from the apex obliquely towards the posterior periphery, much as in some species of *Zirphæa* which, as I have previously mentioned, also indicates a passage from the former to the present family, because it does not possess any accessory valves.

Species belonging to the type of the recent *Sp. mytiloides*, Lam., or *Sp. rostrata*, Sow., are known already in the cretaceous period, as will be seen in my subsequent list of the cretaceous species of *GASTROCHÆNIDÆ*, and it is probable that they will also be found in older formations.

2. *Rocellaria*, Fl. de Bell., 1802, (H. and A. Adams, Gen. ii, p. 335). Valves equal, widely gaping in front and below; surface of the shell regularly striated, not interrupted in the middle area; tube claviform, rather short;—boring in shells, limestone rocks, etc.

As regards specific forms this is the most numerous genus of the family; the species are found in all seas, though most numerous in tropical countries where coral-reefs are formed. Fossil species are known from the Trias upwards, gradually increasing in number and variety, until they reach their maximum of development at the present time.

3. *Cucurbitula*, Gould, 1861, (Proc., Bost. Soc. Nat. Hist., vol. viii, p. 22). Valves equal, gaping the whole length; tube very short, ovate, composed of cup-shaped layers, involving shell-fragments, etc.; it is usually attached by one side to foreign objects. The type is *Cucurb. cymbia* of Spengler.

4. *Gastrochæna*, Spengler, 1780, (*Fistulana* auctorum). Valves sub-equal, edentulous, narrow, gaping very nearly the whole of the ventral side. Tube straight, closed in front, with a perforated septum behind the valves;—boring in sand and mud.

Tubes which in external appearance are almost identical with those of *Gastrochæna* are first met with in the Trias, but the occurrence of true species of this genus is at present only recorded on good evidence from cretaceous deposits; the species are, however, rare, continuing with the same scarcity through the tertiary deposits, and there are living only three known.

b. *Sub-family*,—*CLAVAGELLINÆ*.(BRYOPINÆ and CLAVAGELLINÆ of Tryon, *Clavagella*, Deshayes).

Shell with only the right valve free, the left one permanently grown together with the tube. The mantle of the animal must consequently overlap the right valve altogether, causing it to be in some respects internal.

5. *Bryopa*, Gray, 1840, (Tryon, in Proc. Phil. Acad. Nat. Sc. for 1861). Valves generally triangular, unequal; tube short, posteriorly with a siphonal fringe, anteriorly mostly of irregular shape, enlarged, compressed, in front with a minute fissure.

5a. *Dacosta*, Gray, 1858, (see Tryon, *loc. cit.*), was separated sub-generically to include *Cl. australis* and *balanorum*, both of which are stated to have no siphonal fringe at the posterior end of the tube; the last named is supposed by Tryon to be only the young of *Bryopa aperta*, Sow.

6. *Clavagella*, Lam., 1812, (see Deshayes Fossil du bass. de Paris, 2nd edit., 1860, vol. i, p. 80, etc.). Valves oval, or sub-oval, nearly equal, short tubuli formed all round the margins of the valves where they come in contact with the tube; the latter is long and laterally compressed. If an anterior fissure exists, it must be quite irregular and very small.

7. *Stirpulina*, Stol., 1869. Valves ovate, sub-equal, similar to those of *Clavagella*, but tubuli formed only at the front part of the tube which has a distinct fissure; tube long.

The tri-division of the Lamarckian genus *Clavagella* was first proposed by the able French conchologist, S. Rang, and afterwards revised by Deshayes in his "Traité elem. de Conchiliologie." In his last edition of the Paris fossils the same author enters upon this question in detail, but he does not consider the groups sufficiently distinct to warrant generic distinctions; I feel, however, certain that they are equally well definable as scores of others. That passages from one into the other do occur is only natural, and must be expected, as the result of further analysis and of our increasing knowledge, not only in this but in all other similar cases. Palæontology must greatly assist in the discovery of connecting links between forms which appear to be at the present perfectly isolated. The three genera which I mentioned above are distinct in their habits, connected with some variations in the form of the animals and shells. They all seem to possess the faculty of producing more or less prolonged tubuli, which originate at the edges of the mantle.

The recent species which have been called by Gray *Bryopa* generally live in solid rock or coral, and do not, as a rule, secrete tubuli of any great length. Deshayes says, however, that this is entirely owing to local influences, and if it happens that there are any fissures in the rock, a few tubuli are readily formed as observed on fossil species. Such is also the case, he says, with *Bry. (Clav.) balanorum*; thus we have again a transition from *Bryopa* to *Clavagella*, but still partaking more of the general characters of the former than of the latter.

no fossil is even assigned to the latter genera

Deshayes brings in support of his unity of Lamarck's *Clavagella* some fossil species, saying that the usual triangular shape of the valves of the recent *Bryopa* is connected with the characters of what has here been called *Clavagella*. This is, as regards the form of the valves, quite correct; the triangular shape passes gradually into an oval, but the shape of the valves has, strictly speaking, not been considered as one of the striking distinctions of *Bryopa*. Sandberger (Mainzer Becken, pl. 21, fig. 3,) figures such a *Clavagella* in which the valves are intermediate in shape between those of other fossil *Clavagellæ* and the recent *Bryopa*, but it distinctly secretes tubuli on the mantle edges like the former, and its habitat also corresponds with it. The known fossil *Clavagellæ* generally bore in shells, or near the surface of corals, having the ventral side, where the longest tubuli are formed, free. Very often these tubuli are found secreted all round the edge of the mantle, that is, along the margins of each valve; this is probably more commonly the case in such species as bore in sand, than in those which attack shells. The largest number of the fossil species belong to *Clavagella*, as restricted.

In the third form for which I have proposed the name *Stirpulina*, and which is represented by the well known fossil species *Stirp. (Clavagella) coronata* or *bacillaris* of Deshayes, the tubes are closed in front, the diaphragm being perforated about the middle by a narrow slit, and at the edges surrounded by numerous irregular tubuli. The valves are subequal, the left being usually the smaller one; the tube is very similar to that of *Brechites*, and the species, like those of the last named genus, lived in sand. It even appears difficult in some fossil species to ascertain, whether only one or both of the valves were attached to the tube, thus indicating an intimate connection between the fossil *Stirpulina* and the recent forms of *Brechites*. I shall subsequently mention the representatives of this sub-family recorded as occurring in cretaceous deposits.

c. Sub-family,—*BRECHITINÆ*.

(See H. and A. Adams, Gen. ii, pp. 649-650).

Both valves grown together with the tube, the anterior base of which is provided with tubuli, usually arranged in a fringe round the disc, being more or less perforated and possessing a sub-central narrow fissure.

8. *Humphreya*, Gray, 1858. Tube irregular, attached to foreign objects with its anterior ventral termination; but two specimens of the only species, *H. Strangei*, have as yet been found, and it has not been ascertained whether their growth is normal or abnormal; the latter is more likely the case.

9. *Brechites*, Guettard, 1774, (*Aspergillum auctorum*). Valves on the tube considerably exposed, their outlines distinctly marked; posterior end of the tube simple.

9a. *Warnea*, Gray, 1858. Posterior end of tube fringed, otherwise as in *Brechites*.

10. *Foegia*, Gray, 1840. Only the umbones of the valves exposed on the tube, more or less covered by a tubercle in front of them. The two species, *F. agglutinans* and *Zebuensis*, are, judging from Chenu's figures, most probably identical.

Gray distinguishes a sub-genus, *Arytene*, (including *Foeg. Recluziana* and *tuberculata*), said to differ from *Foegia*, as restricted, by its simple disc, but in both the species the marginal tubuli are considerably projecting, and united to a simple fringe. The sub-generic distinction appears to me scarcely to have any value.

10a. *Penicillus*, Gray, 1840. Tubercle in front of the umbones of the valves obsolete. The separation of *P. strangulatus*, Chenu, again as a separate sub-genus, *Clepsydra*, seems to me quite unnecessary. *Brech. Javanus* gives an example of this, for in this species there are occasionally two fringes developed round the disc, while in other specimens of the same locality there is only one.

All the *BRECHITINÆ* live buried in sand and mud, in a more or less perpendicular position. They are comparatively rare shells, and a comparison of numerous specimens of the various species would probably show no necessity for separating even those three generic divisions which I have here adopted. There are a few tertiary species known, but none with certainty from the cretaceous or older deposits.

Of the first sub-family, the *GASTROCHÆNINÆ*, Pictet, (Pal Suisse, 3^{me} Ser., 3^{me} pt., p. 17,) quotes 16 species, among which we find representatives of *Spengleria*, *Rocellaria*, and *Gastrochæna*.

1-2.—*Gast. arcæformis* and *Sanctæ-crucis*, P. and Camp., are the earliest known representatives of *Spengleria*.

3-18.—*Gast. dilata*, Desh., *G. sinuosa*, Pict. and Camp., *G. Valangiensis*, P. and C., *G. astræarum*, P. and C., *G. Rathieriana*, Cott., *G. Matronensis*, d'Orb., *G. gaultina*, P. and C., *G. brevis*, P. and C., *G. Royanensis*, d'Orb., (alias *Royana*), *G. ostrea*, Gein., and *G. pistilliformis*, Reuss, belong to *Rocellaria*; *G. pyriformis*, Mant., *G. Marticensis*, Math., and *G. tenuis* of Geinitz, are doubtful, but the excavations also resemble in every respect those of *Rocellaria*. The same can be said of *Gast. Essensis* and *Tornacensis* of Ryckholt, (Mél. paléont., 1^{ere} pt., 1852, p. 119).

Some other species, like *Gast.*, or *Fistulana*, *amphisbæna*, Goldf., *Gast. voracissima*, Müller, &c., I have already noticed when speaking of the *TEREDINÆ*. Ryckholt (Mél. paléont., loc. cit., p. 118, pl. 5, figs. 19-22,) gives, among others, the figure of a valve which he states to have been found in the tube referred to *Gast. amphisbæna* of Goldfuss and Geinitz. The valve is certainly not that of a *Teredo*, but neither has it the appearance of a *Rocellaria*, unless it is very much worn off; it would more probably be that of a *Clavagella*, but there are no tubuli known to occur on the end of the tube. In spite of Ryckholt's statement, I think, there is more decisive proof required to show, that those tubes really belong to a species of the *GASTROCHÆNINÆ* and not to the *TEREDININÆ*, to the latter of which they have undoubtedly a far greater resemblance. *Gastroch. socialis* of Eichwald has been subsequently placed by the same author in the genus *Teredo*. In Leth. Ross. xi livr., p. 721, the same author, however, describes a *Gast. cylindrica*, Fahrenkohl, which is said to occur in Neocomien beds near Moscow, these being, however, by several other able geologists referred to the jurassic period. *Gast. sinuosa* of Pictet and Camp. is also mentioned here from some other Neocomien beds.

19.—To the 16 known species of *Rocellaria* I shall add from our South Indian cretaceous rocks one, *R. guttula*, and the tube of another species probably belonging to the same genus.

20.—Zittel described from the Gosau deposits a *Fistulana tubulosa*, which has now to be called a *Gastrochæna* (Denksch. Akad., Wien, 1865, xxiv, pt. 2, p. 108, pl. 1, fig. 1).

21-22.—*Gast. americana*, Gabb, (Jour. Phil. Acad., 2nd Ser., vol. iv, p. 393, pl. 68, fig. 20), is to all appearance a true *Gastrochæna*, and the same must be said of the South Indian *Fistulana aspergilloides* of Forbes.

The *CLAVAGELLINÆ* have representatives in cretaceous deposits, belonging to the genera *Clavagella* and *Stirpulina*.

23-26.—Pictet (loc. cit., p. 6,) enumerates four European cretaceous species of *Clavagella*, *C. cretacea*, d'Orb., and *C. clavata* (? *Teredina clavata*, Röm., sp.), may either belong to *Clavagella* or to *Stirpulina*; in neither case do the specimens seem to have been sufficiently well preserved. *Cl. Cenomaniana* and *Cl. Ligeriensis*, d'Orb., are known only by their names.

27-28.—Müller (Suppl. to Monograph der Petref. der Aachner Kreidef., 1859, p. 17,) described two species, *Cl. elegans*, which is a *Stirpulina*, while the other, *Cl. divaricata*, is very doubtful, being based upon a single valve which is rather different from the usual type of *Clavagella*.

29.—*Cl. cornigera*, Schafh. Süd-Bayerns (Leth. geogn., 1863, p. 179), is apparently a *Stirpulina*, although the figure does not exhibit any difference in the valves; it would seem as if both valves were free, or both grown together with the tube; in the latter case the species must be transferred to *Brechites*.

30.—*Cl. exigua*, Zittel, (Denksch. Akad., Wien, vol. xxiv, 1865, pt. 2, p. 107,) is from the Alpine Gosau-deposits.

31.—From America only one species is known, *Cl. armata*, Mort., which is very similar to the last, and probably a *Stirpulina*.

32.—*Cl. semisulcata*, Forbes, will be described subsequently.

33.—The only notice of a species possibly belonging to the *BRECHITINÆ* is by Rominger in Bronn's Jahrbuch f. Min. for 1847, p. 659, where the author mentions a new species, *Aspergillum cretaceum*, from the Turonien beds of the county of Glatz. No further notice beyond the name has been published; probably the species is the same as the one described by Schafhæutl, noted above.

Thus on comparing the species of *GASTROCHÆNIDÆ*, represented in cretaceous rocks, we find that more than two-thirds belong to the *GASTROCHÆNINÆ*, somewhat less than a third to the *CLAVAGELLINÆ*, while the occurrence of *BRECHITINÆ* is doubtful, and in any case their number would be the smallest. The *GASTROCHÆNINÆ* are already known from the Trias and gradually increase up to the present time; the *CLAVAGELLINÆ*, however, have not as yet been met in strata older than the cretaceous.

V. ROCELLARIA, Fl. de Bell., 1802, (see p. 26).

1. ROCELLARIA GUTTULA, Stoliczka, Pl. I, Fig. 7.

R. testa valvis ovato-elongatis, convexiusculis, sublævigatis, antice acutiusculis, postice sub-truncatis, valde inæquilateralibus; hiatu antico magno, lato, postice fere ad dimidium longitudinis extenso; tubis brevibus, regulariter ovatis, antice rotundatis, postice rapide contractis, atque breviter prolongatis.

The tubes formed by this species are very characteristic; they are regularly ovate, inflated, but at the posterior end rapidly attenuated and shortly produced. The valves are large, high, posteriorly truncate, and the gape reaches on the ventral side to only about half the length of the shell.

Locality.—Odium and Moraviatoor; generally found boring in oyster shells.

Formation.—Ootatoor group.

2. ROCELLARIA SP. IND., Pl. I, Fig. 8.

A single tube, apparently belonging to a *Rocellaria*, has been found in the uppermost beds of the Arrialoore group at Ninnyoor; it is somewhat cylindrical, being roundish at the anterior end, and becoming gradually narrower towards the posterior termination, which is laterally somewhat compressed. The species to which this tube belongs is no doubt different from the former, and it is to be hoped that further researches will lead to the discovery of the valves.

VI. GASTROCHÆNA, *Spengler*, 1780, (see p. 26).1. GASTROCHÆNA ASPERGILLOIDES, *Forbes*, Pl. I, Fig. 12.

1846. *Fistulana? aspergilloides*, Forbes, Trans. Geol. Soc., Lond., vii, p. 139, pl. 17, fig. 2—*idem* auctorum.

Gast. tubo tereti, longo, sub-cylindrico, concentrice sulcato, antice abrupte terminanti, clauso, convexiusculo, acute marginato.

The great length and the anterior abrupt termination surrounded by a sharpened edge fairly distinguish this tube from that of any other cretaceous or tertiary species. The valves could not be exposed. The only specimen as yet found is the original of Forbes' description, of which I also give a figure.

Locality.—Pondicherry, in greyish sandstone.

Formation.—Arrialoore group.

VII. CLAVAGELLA, *Lamarck*, 1812, (see p. 27).1. CLAVAGELLA SEMISULCATA, *Forbes*, Pl. I, Figs. 9-10.

1846. *Clavagella semisulcata*, Forbes, Trans. Geol. Soc., Lond., vii, p. 139, pl. 17, fig. 1—*idem* auctorum.

Cl. valvis ovalibus, tumescentibus, umbonibus obtusiusculis, anticis instructis, concentrice minute striatis; tubulis brevibus, irregularibus, in tota peripheria marginali valvæ adnatæ et pariter magna ex parte in ea valvæ liberæ sitis; tubo producto, lente arcuato, sub-lævigato, lateraliter compresso ac obsolete bi- seu tri-sulcato.

The oval form of the valves and the obtuse beaks of the shell when well preserved (fig. 10), and the laterally compressed tube, appear to be good distinguishing characters of this species. In the cast (fig. 9) the beaks are more prominent. The left valve is, as usual, grown together to the tube, though well marked on its surface (see figs. 9 and 10), the right valve is covered over by the shelly tube; short tubuli rather irregularly placed are seen nearly all round the periphery of the valves; along the margin of the imbedded (right) valve they are, however, much less developed, and in places nearly obsolete. I have given a figure of Prof. Forbes' original specimen after it had been freed from the rock in which it was enclosed.

Locality.—Pondicherry, in a light bluish or greyish sandstone.

Formation.—Valudayur group.

II. Order. MYACEA.

The only characters, common to the largest number of Pelecypoda referable to this order, are a short lingui- or digiti-form foot and elongated, partially, or entirely united, siphons, into which, however, the branchia are but slightly, or not at all, prolonged.

The valves are generally well developed, covering the whole animal; they are more or less solid, gaping posteriorly, attached to each other by an internal cartilage, and joined by a hinge with few, or sometimes obsolete, teeth; not unusually there is also an external ligament present, but it rarely excludes the presence of the cartilage. Most of the species burrow in sand and some also excavate solid objects; the entire shell is often covered with an epidermis, which usually extends over the united portion of the siphons, and in this respect seems to replace the calcareous tube of the *PHOLADACEA*, which is especially apparent in those cases in which it becomes, (as in the typical genera *Mya* and *Anatina*),—almost perfectly coriaceous, and non-retractile within the valves.

The families which may be considered as constituting the order, are the *MYIDÆ*, (*CORBULINÆ* and *MYINÆ*), *MACTRIDÆ*, (*LUTRARIINÆ* and *MACTRINÆ*), *ANATINIDÆ* (*PANDORINÆ*, *THRACIINÆ*, and *ANATININÆ*), *SAXICAVIDÆ*, *GLAUCONOMYIDÆ*, and *SOLENIIDÆ*. The various genera of these families are somewhat differently allied to the previous and the next order: for instance, *Sphenia*, of the *MYIDÆ*, is in an equal degree related to the *GASTROCHÆNIDÆ*, as is *Saxicava*, (belonging to the *SAXICAVIDÆ*). The *LUTRARIINÆ*, of the *MACTRIDÆ*, are undoubtedly most closely allied to the *Myæ* and some species of the *ANATINIDÆ*, while the *MACTRINÆ*, as restricted, in external aspect, much resemble some *VENERACEA*. Again, among the *ANATINIDÆ* the *Pholadomyæ* recall several forms of *PHOLADINÆ*; some shells of the *THRACIINÆ* are externally almost undistinguishable from others belonging to the *TELLINIDÆ*, while genera, like *Novaculina* (of the *SOLENIIDÆ*) are truly intermediate between *Tellina* and *Solen*, as regards shells as well as animals, for they have long divided siphons, like *Tellina*, but a short club-shaped foot, like *Solen*.

These various relations make it really almost impossible to bring the families into an arrangement, by which a gradual passage from one to the other would become clearly exhibited, but the arrangement here adopted may for the present, probably, best answer our as yet imperfect knowledge of the order, especially when we pay due attention to the very large number of fossil forms. For this deficiency is largely due to the latter, the greater number of which we only know from their external shape; rarely is there an opportunity offered to examine the internal characters of the fossil shells. The order includes, however, some of the oldest known fossil forms. In the palæozoic times the species were not very numerous, but they increase considerably in the lower mesozoic epoch and attain their maximum of development in the middle and upper mesozoic times. The tertiary forms are less numerous in species, though more varied as regards generic types; many of the older forms have then almost entirely disappeared, and thus

the difficulty of obtaining a natural arrangement in those species which survived up to the present time is increased. Until, therefore, those connecting links are all properly examined and their relation to the recent species established, we must be satisfied with a provisional grouping.

The position of the *MACTRIDÆ* next to the *MYIDÆ* and that of the *GLAUCONOMYIDÆ* as intermediate between the *SAXICAVIDÆ* and the *SOLENIIDÆ* will probably be found an unusual one, but I think the anatomy of the animals and the general character of the shells fully account for it, as I shall endeavour to prove by giving further details when speaking of these families. I have also placed the *SAXICAVIDÆ* nearer to the *SOLENIIDÆ* as is usually done, not with a desire to diminish the striking relation of *Saxicava* and *Rocellaria* (*GASTROCHÆNIDÆ*), but principally on account of the very great resemblance existing between the *Panopeæ*, (especially the many fossil species,) and the *Pleuromyæ* and *Pholadomyæ*, and also on account of *Cyrtoria* very much recalling the form of true *SOLENIIDÆ*.

III. Family,—*MYIDÆ*.

The animals of the *MYIDÆ* generally are unsymmetrical, with a small digitiform foot, and united, more or less distinctly retractile, siphons, prolonged and occasionally separated at their ends; there are two gills on each side, about as long as the posterior half of the body, not prolonged in the siphons; the labial palpi are pectinate and occupy the posterior two-thirds of the anterior half of the body.

The shell is more or less inequivalve, solid, porcellaneous, covered with a thick epidermis, extending over the siphons. The cartilage lies in each valve internally in a special groove, sometimes supported by spoon-shaped processes. Some genera possess a shelly or horny capsule (the ossicle) covering the cartilage internally; this ossicle is, however, more characteristic for the *ANATINIDÆ*.

I accept here the family *MYIDÆ* in Deshayes' sense, who unites the *CORBULIDÆ* and *MYIDÆ* of H. and A. Adams into one. They will include the following genera: *Himella*, *Sphenia*, *Corbula*, *Corbulamella*, *Eucharis*, (*Basterotia*), *Pleurodesma*, *Corburella*, *Spheniopsis*, *Neæra*, *Poromya*, *Azara*, *Corbulomya*, *Cryptomya*, *Tugonia*, *Platyodon* and *Mya*; some are divided into one or more sub-genera.

It is really difficult to make any strict separation of the two families. The animal of *Mya* possesses long united siphons and a deep pallial sinus, while in the other genera the siphons and the sinus are proportionally much shorter. The animal of *Tugonia* is not known, and its shell is rather thin, as compared with other *Myæ*, but it is of the same type and general form as the rest. Of all the other species the shells, however, agree in their solid structure and in the position of the internal cartilage, the external ligament being either very small, or more often quite obsolete. In order to preserve the one uniform type of shells, it is preferable to treat them in one family, and to distinguish two sub-families, *CORBULINÆ* and *MYINÆ*. The former will include the genera which usually have a raised cartilage-pit in one and a subtriangular process in the other valve, both being usually closed; the animals

have the siphons short; the shells of the other sub-family have a very large cartilage process in the left valve, — except *Tugonia*, which has it in both, — they are elongated and gaping posteriorly; the animals have long united siphons. If we compare *Mya* with *Cryptomya* (*Nuttallii*, for instance), the principal difference to be detected between the two is the very short pallial sinus in the latter. Some species of the fossil *Corbulomya*, and other recent ones belonging to *Azara*, fully establish again a connection between *Corbulomya* and *Corbula*, both in form, position of the cartilage, and pallial impression. *Neæra* inclines to the *ANATINIDÆ* in the structure of its shell, but its form and the organisation of the animal place it near *Sphenia*. *Poromya*, especially in its fossil forms, of which only the last remnants appear to have survived the great terrestrial and climatal changes, must, according to the organisation of the animal, the form of its shell and that of the hinge, be placed near *Corbula*, though the structure of the shell and the presence of a rather strong external ligament have some relation to *Pholadomya*. Thus it is at one time the majority and at another time the importance of the characters, common to a number of shells, which must be made use of in classification.

Of all the generic types *Sphenia* is most closely allied to the *GASTROCHÆNIDÆ*. The animal is almost identical with that of *Rocellaria*, and the shell is very similar to it, especially when the hinge-teeth become obsolete. It is generally indented on the antero-ventral margin, indicating the gape of *Rocellaria*. I have besides observed species of *Sphenia* which sometimes form posteriorly a regular prolonged tube, in as much as the epidermis, covering the siphons, becomes very much hardened. Its burrowing habit also indicates the relation just mentioned.

The 5th part of the 4th Volume, 1868, of the American Journal of Conchology (Appendix p. 62, &c.), contains a catalogue of the recent species of the *MYIDÆ* and *CORBULIDÆ* by G. W. Tryon, Junr. The former contains 10 species and the latter 85, excluding *Neæra* and *Poromya*; but, even neglecting these two last named genera, the list does not appear to be as complete as it would seem desirable.

I shall again, as on the previous occasions, first give a short review of the recent and fossil genera, referable to the family, then note the species represented in cretaceous rocks, and at last give descriptions of the species occurring in the South Indian cretaceous deposits; the latter are characterized by three genera only, *Corbula*, *Poromya*, and *Neæra*.

a. Sub-family, — *CORBULINÆ*.

The genera, as far as known, appear to arrange themselves naturally as follows:

1. *Himella*, H. Adams, 1860, (Proc. Zool. Soc. for 1860, p. 369). Shell thin, with the left valve larger than the right one, not gaping; hinge of the right valve with an indistinct tooth fitting into a pit in the left valve; cartilage internal, lying in both valves in an almost horizontally extending process; an external ligament is besides present; pallial sinus scarcely noticeable. This genus is based upon a fluviatile species, *H. fluviatilis*, from the Maranon river.

I could add here the fossil genus *Quenstedtia*, but as it does not seem to possess internally a cartilage, it had better be removed to the *SAXICAVIDÆ*.

2. *Sphenia*, Turton, 1822. Shell oblong, gaping posteriorly, covered with an epidermis, which extends over the united siphons; right valve larger than the left. Hinge with two (one above the other) small teeth in the right, and one in the left, or with one tooth in the right valve and a corresponding pit in the left one; or the teeth are in both valves obsolete; cartilage internal, situated in a separate oblique pit in each valve; pallial sinus moderate; muscular impressions comparatively large.

H. and A. Adams correctly remark that this genus ought to be restricted to the oblong or sub-quadrangular species of the *Sph. Binghami* type; several other forms described as *Sphenia* partially belong to *Corbulomya*, *Corbula*, and allied genera. The prolonged siphons and the short digitiform byssiferous foot fairly distinguish the animals of this genus from those of *Corbula*. The hinge is occasionally very similar in both, but seems to vary a great deal, as noted above. I observed those variations of the hinge-teeth in two species found living about Calcutta, both allied to *Binghami*. The development of the teeth does not always depend upon the age, some young specimens having them perfect and others not, but, as a rule, the hinge-teeth become obsolete only in adult shells, thus evidently indicating a relation to some of the *GASTROCHÆNIDÆ*. There is a distinct process in each valve (though larger in the left one) for the reception of the cartilage, while in *Corbula* such a distinct process does not exist in the right valve, the cartilage lying there in a deep pit. Besides this *Sphenia* occasionally possesses a trace of an external ligament, placed at the upper end of the cartilage-pit, just behind, or rather below, the beaks; of this ligament I could find no distinct trace in several species of *Corbula* examined for that purpose.

3. *Corbula*, Brug., 1792. Shell inequivalve, the left valve being the smaller one; covered with a more or less rough epidermis; hinge with one prominent tooth in the right valve, in front of a cartilage-pit, corresponding to a strong cartilage process in the left valve; pallial sinus very small or not marked at all. I am not acquainted with any fresh water species of true *Corbula*, but there certainly are brackish forms, which cannot be generically separated from the typical marine species of this genus, except that their shells are remarkably thin, resembling those of *Neæra*.

A very peculiar tertiary form of a *Corbula* (n. sp.), in external appearance not unlike an *Azara*, is described by Helmersen in the Bull. phys.-math. de l'acad., St. Petersburg, (1845, vol. iv, p. 7). It has a broad tooth in each valve and a groove next to it for the reception of the tooth of the other valve. In the left valve there are two partially obsolete vertical ribs below the umbo. It is probable that this form to which, as far as I know, no specific name is yet applied, will have to be made the type of a new genus, but this cannot be done without previous careful comparison of the typical specimen.

4. *Eucharis*, Recluz, 1850, Journal de Conch., i, p. 167, (? = *Basterotia*, Mayer, 1859, in Hörnes' Foss. Moll. des Tert.-beckens von Wien, vol. ii, p. 40).

Shell equivalve, or nearly so, inflated, closed on both ends, beaks incurved; hinge with one tooth below the umbo in the right valve and two teeth in the left one, the posterior of which is smaller and appears to be only an anterior thickening of the nymphæ for the support of the cartilage. The margin of the shell, just behind the beaks, is for a very short distance somewhat thickened for the attachment of a ligament; no pallial sinus; muscular impressions rounded.

The genus *Basterotia* was proposed by Mr. Mayer for a tertiary species, *Bast. corbuloides*, and first published by the late Dr. M. Hörnes in his work on the Vienna tertiary Mollusca. Dr. Hörnes refers to the recent *Corbula quadrata* as being a species very similar in shape to the fossil *Basterotia*, and probably belonging to the same genus. I have not examined this species myself as to the exact form of the hinge, but it is the type of Recluz' *Eucharis*, and this author mentions the presence of one oblique large tooth in each valve and an external ligament. The posterior tooth in the left valve Recluz does not notice, but I have no doubt that both forms belong to one and the same genus, as suggested by Hörnes. I had the opportunity of examining one valve of a species found by Mr. G. Nevill at Ceylon. Its hinge perfectly agrees with the fossil *Basterotia*, and the form of the shell is also very similar, only less tumid and somewhat longer. Recluz (l. cit., p. 168,) describes a third recent species, *Euch. elliptica*, which is not carinated. The upper tertiary *Corbula quadrata*, Nyst, (identical with the recent *Poromya anatinoides* of Forbes, also known under the name of *Embla Korenii*, Lovén,) cannot be, I believe, generically identified with *Eucharis*, as I shall state further on, when speaking of the genus *Poromya*. Jurassic forms like *Corbula carinata*, Buvignier, may belong to *Eucharis*.

Speaking of equivalve forms I should also mention the jurassic *Corb. Glosensis*, described by Zittel and Goubert (Journal de Conch., 1861, p. 196). The right valve has one large cardinal tooth and the left only a cardinal pit. If this description of the hinge is correct, it would indicate a new genus of the *CORBULINÆ*, intermediate between *Corbula* and *Eucharis*, unless the species is a *Quenstedtia*.

5. *Pleurodesma*, Hörnes, 1859, (foss. Moll., Wien, vol. ii, p. 43). Shell oblong or quadrangular, equivalve, closed on both sides, one large cardinal tooth in each valve, and a long groove extending along the dorsal margin of the shell for the reception of the cartilage; there is no indication of the presence of a ligament. This genus has been proposed for a new tertiary shell, *Pl. Mayeri*, which in general form agrees with *Eucharis*, but differs widely from it by the form of the hinge.

6. *Corburella*, Lycett, 1853, (1850?), (Proc. Cottesw. Nat. Club, vol. i, p. 83), was established for a jurassic species figured by Phillips (Geol. Yorksh., 1835, i, pl. 3, fig. 27,) under the name of *Corbula curtansata*. Lycett gives the following generic character. "Shell equivalve, thin, inflated, posteriorly attenuated and gaping, anteriorly rounded, hinge with a small depressed subconical tooth in each valve, and extended, slightly thickened, laminar plate forming a kind of an anterior lateral tooth or process." Ligament and pallial sinus are not noticed, nor are they perceptible in Phillips' figure. As to general form of the shell the genus would

stand near *Neæra*, but the tooth in each valve would recall *Eucharis*. Whether the anterior laminar process occurs in both valves and whether it is for the purpose of supporting the cartilage, which seems likely, has yet to be satisfactorily determined. Lycett does not mention this genus in the large work on the fossil Mollusca of the Great Oolite.

7. *Corbulamella*, Meek and Hayden, 1857 (Proc. Acad. Nat. Sc., Phil., p. 142). Shell sub-triangular, sub-globose, inequivalve, the right valve being more ventricose than the left; beaks nearly central; hinge with one cardinal tooth in each valve, apparently very similarly arranged in position to that of *Corbula*, but the existence of an internal cartilage has not as yet been satisfactorily proved; anterior muscular impression rather indistinct, posterior on a special raised or projecting plate; pallial impression scarcely sinuated posteriorly.

This is proposed for a cretaceous species from Nebraska, *C. gregarea*; it resembles *Cardilia* in form, but is distinguished from this by the irregularity of the valves.

8. *Spheniopsis*, Sandberger, 1863, (Conch. des Mainzer Tertiær-beckens, p. 289). Shell sub-trigonal, compressed, equivalve, posteriorly rostrate and slightly gaping; hinge of right valve with an anterior cardinal tooth, and a deep cartilage-pit behind it, a long laminar tooth runs along the areal margin; left valve edentulous, only provided with a cartilage-pit; pallial sinus deep. This genus is based upon a tertiary species, which is an intermediate form between *Corbula* and *Rhinomya* (a sub-genus of *Neæra*). It may also be considered to represent a compressed *Poromya*. Sandberger calls the shell equivalve, but the presence of the posterior laminar tooth in the right valve seems to me to indicate that the left valve must be a little smaller, in order to fit to the right one without possessing a special double tooth. *Neæra jugosa*, Wood, (English Crag. Moll., vol. ii, p. 272,) very likely belongs to *Spheniopsis*.

9. *Neæra*, Gray, 1834. Shell inflated, thin, posteriorly prolonged and gaping, right valve somewhat smaller; one cardinal tooth in each valve, spoon-shaped for the purpose of supporting the cartilage, occasionally with a minute tooth in front of it, a lateral posterior tooth, much larger and more distinct in the right valve than in the left; ossicle distinct, small; ligament external, very small, situated just behind the beaks. The thin, usually finely lamellar structure, and the inflated form of the shells belonging to this genus, are very characteristic. H. and A. Adams place it in the *ANATINIDÆ*, though judging from the form of the shell, being in many respects similar to that of *Corbula*, and also from the form of the small foot and the short siphons of the animal, there can be little doubt that Deshayes' classification near *Sphenia* and *Corbula*, etc., is the more correct one. Almost the only character which some species of the genus have in common with the *ANATINIDÆ* is the presence of a small ossicle at the cartilage, but as all the *ANATINIDÆ* do not possess the same, its presence cannot be regarded as an exclusive character of that family. Nearly all the species of *Neæra*, living in deep water, possess a thin shell, often very finely punctated; only very few, being more littoral in their habits, have a rather solid and opaque shell, like *Mya* or *Thracia*.

9a. *Rhinomya*, A. Adams, 1864, (Ann. and Mag. Nat. Hist., vol. xiii, p. 207). This was proposed as a sub-genus for such forms as have the surface of the shells lamellar, like *Neæra* proper, but possess a small triangular cartilage-pit, and two lateral teeth in the right valve.—*N. (Rh.) Philipinensis*, Hinds.

9b. *Cardiomya*, A. Adams, 1864, (ibid, p. 208) ought apparently to include the species of *Neæra* which have the surface radially ribbed, like *N. Gouldiana* of Hinds.

H. and A. Adams, in their work on the genera of Mollusca (ii, p. 369,) class *Theora* next to *Neæra*, apparently following the suggestions of Hinds regarding the relation of these two genera, Hinds having first described a few species of *Theora* under the generic name of *Neæra*. I have examined the animal of some species of *Theora*, which chiefly live in brackish water along the coast of the Bay of Bengal, and found them to be allied to those of the *SCROBICULARIIDÆ*, to which family the genus must be referred. On account of a very marked relation of the fossil *Palæomya* to *Theora*, I shall treat of the former also in the last named family, and the same applies to a peculiar recent shell called *Plectodon* by Carpenter.

10. *Poromya*, Forbes, 1844. Shell oval, equivalve, ventricose, gaping posteriorly, covered with a scabrous epidermis, below which the surface is either punctated, or granular, or finely spinulose, the unevenness of the surface appearing to give firm attachment to the epidermis. Hinge with a strong tooth in the left valve, and two smaller ones in the right, and in each with a posterior groove, in which is lodged a small cartilage; fulcra prominent for the attachment of a more or less strong ligament; pallial line submarginal, and posterior sinus small.

Deshayes (Paris fossils, 2nd edit., p. 248,) correctly,* I think, suggests, that the fossil shells which Sowerby called *Thetis*, and which name has been adopted by H. and A. Adams in preference to that of Forbes, are thoroughly distinct from those belonging to the present genus. Of the former I shall treat in the *VENERIDÆ* (sub-family *DOSINIINÆ*).

The first *Poromyæ* as yet known are only from cretaceous rocks, though very little doubt exists that the genus is much older. Of recent shells there are not much more than about half a dozen species known (see A. Adams in Ann. Mag. Nat. Hist., xiii, 1864); they are deep water shells, and have been found in European and Chinese seas. The form of the siphons and of the foot, equally with that of the shell and its hinge, necessitate, as already pointed out, the classification of this genus in the *CORBULINÆ*, in preference to that in the *ANATININÆ*. *Poromya* is not identical with *Eucharis*, Recluz, but *Embla Korenii* of Lovén is identified by Sars, and by other very able observers of the North-European marine fauna, with the type species *Poromya granulata*, Nyst. Gray formerly placed *Embla* (as distinct from *Poromya*) in the *LASSEIDÆ*.

11. *Azara*, d'Orbigny, 1839. Shell like *Corbula*, right valve with two obscure teeth, separated by a broad pit, in which fits the process of the left valve supporting

* Subsequently (ibid. p. 408) he alludes to the great similarity of Sowerby's *Thetis* and *Poromya*, but I do not think that this statement has more weight than the former.

the cartilage. Chenu (Man. ii, p. 33,) states, that there are three muscular impressions present, a posterior oblong, an anterior transverse, and a third small one between the latter and the hinge.

This genus, which, by the hinge of its shell and by the long siphons of the animal, is well distinguished from *Corbula*, includes a number of estuary shells from South America; it is in many respects intermediate between *Neæra* and *Corbulomya*; it is also sparingly represented in our eastern seas, the Philipines, and the Bay of Bengal.

12. *Corbulomya*, Nyst., 1846, (Coquill. foss. de la Belgique, p. 59). Shell transversally ovate, closed on both ends; right valve larger, with one cardinal tooth in front of a cartilage-pit; left valve with two distant teeth, the posterior of which supports the ligament; pallial sinus very small or obsolete.

This genus has been proposed for fossil species, which appear to be rather numerous in the tertiary formation, but none of them has as yet been sufficiently made known from mesozoic beds, though very likely a number of the small *Myacites*, or *Anoplophoræ*, and others, will be shown to belong to it. A recent species known as *Corb. mediterranea* occurs in the European seas.

The genus closely approaches in the dentition of its hinge *Eucharis*, but in this one the anterior tooth of the left valve is much stronger than the posterior.

13. *Cryptomya*, Conrad, 1848. Shell transversally oblong, rather compressed, generally sub-equilateral, slightly gaping on both ends, more so posteriorly; hinge of both valves with a spoon-shaped cardinal process, receiving the cartilage, the process of the right valve being usually somewhat larger, and having in front a small tooth or a thin ridge; pallial sinus small or none. The surface of the valves is often decussately striated, and such species appear to form a good passage to the next genus.

b. *Sub-family*,—*MYINÆ*.

14. *Tugonia*, Gray, 1842. Shell oval, inflated, with the beaks directed backwards, widely gaping posteriorly, equivalve; hinge consisting of a spoon-shaped, cardinal process in each valve with a small posterior denticle; cartilage internal in the process, ligament external, short, partially extending over the beaks; pallial sinus very small or wanting. There are only a few recent and tertiary species of this genus known; none have been as yet found in cretaceous rocks. This genus could be equally well placed in the *ANATINIDÆ* but it seems to be connected with *Mya* through the next one.

15. *Platyodon*, Conrad, 1837. Shell elongated, inflated, solid, with the surface cancellated, posteriorly widely gaping, equivalve, tooth in the right valve very broad, anteriorly with a short ridge, the beak of the left valve excavated for the reception of the right one. The type of this genus is *Platyodon cancellatus*, the only species as yet known; the animal is said to have at the end of the siphons four testaceous appendages; by the structure of its shell, equal valves and the form of the beaks, this form seems deserving a distinct generic name.

16. *Mya*, Linn., 1747. Shell oblong, moderately tumid, inequivalve, surface concentrically striated; hinge in the left, or smaller, valve with a broad spoon-shaped process supporting the cartilage, which lies in a corresponding pit of the other valve below the beak; pallial sinus very deep; some of the species have the epidermis thickened below the beaks, representing a thin external ligament.

In the present seas the *MYIDÆ* are represented by about one hundred and thirty species, of which *Corbula* is by far the most numerous. From the cainozoic rocks there are about one hundred species described, in the mesozoic the number is somewhat smaller, though the genus *Corbula* always predominates, and from palæozoic beds there are hardly more than twenty species known. Thus, a gradual increase in the development of the various forms is noticed from the oldest epoch up to the present time.

In the palæozoics we only meet with *Corbula*, and perhaps with *Mya* and *Neæra*; in the mesozoics *Sphenia*, *Corburella*, and afterwards *Poromya*, are added; in the cainozoic time *Spheniopsis*, *Pleurodesma*, *Tugonia*, and others appear, most of which are still found recent, though with the exception of *Corbula* and some species of *Sphenia* all belong to the series of rare shells.

The following species have been noticed from cretaceous deposits (see Pictet 'Pal. Suisse,' 4^{me} Ser., 3^{me} pt., p. 36, &c.).

CORBULA.

1-8.—*Corbula incerta*, *neocomiensis*, *compressa*, *striatula*, *elegantula*, *gurgyaca*, *punctum*, and *Edwardi*;—all appear to be true *Corbulæ*.

9.—*C. Costæ* is probably a *Poromya*.

10.—*C. socialis*,—uncertain.

11-13.—*C. gaultina*, *elegans* and *truncata* are true *Corbulæ*.

14.—*C. Leufroyi*. Guéranger figures this species in his "Atlas Paléont. de la Sarthe," pl. 16, fig. 1), and refers it doubtfully to Sowerby's *C. elegans*. The figure is not very characteristic, but distinctly shows the specimen to be longer and less high than the English species described from Blackdown. The former name may, therefore, be retained, until a careful comparison of both has been instituted.

15-16.—*C. Goldfussiana* of Matheron is identified by D'Orbigny with his *C. truncata* (non *idem* Sow.). This appears rather doubtful. If one has to judge from the illustrations given of the two forms, Matheron's figure seems to represent a true *Corbula*, the shell being rather inequilateral and globose. D'Orbigny's figure on the contrary represents a more compressed, much less inequilateral species, which is, besides, nearly equivalve and most likely belongs to *Corbulomya*. Possibly D'Orbigny has compared the original shells and found either one or the other of the figures incorrect, but had this been the case, he would most probably have recorded the fact. Should, however, my suggestion regarding the generic determination of *C. truncata*, D'Orbigny, prove correct, the specific name would not require to be changed.

17.—*C. bifrons* can hardly be identified from the short description given of it.

18.—*C. Bockschi* (non *Bocksii*), (*Crass. Bockschi* olim), appears to me to be more likely a *Trigonia* than a *Corbula*.

19.—*C. subglobosa* is rather uncertain, the shell figured by Goldfuss has not much the appearance of a *Corbula*, and in fact scarcely resembles any other genus of the *MYIDÆ*.

20.—*C. angustata* (see Zittel in Denksch. Akad., Wien, 1865, xiv, pt. ii, p. 112). D'Orbigny calls this species, which is a true *Corbula*, *C. sub-angustata*, and reserves the former name for the tertiary *Mya? angustata*, Sow. This last is, however, certainly not a *Corbula*, though I would not venture to assert positively to what genus that shell belongs without examining the original specimen itself; it may be a *Himella* or *Corbulomya*, but the cartilage process appears to be similar to that of *Cryptomya*, to which genus it also probably belongs.

21.—*C. substriatula* is a true *Corbula*.

22.—*C. lineata* of Müller is more likely a *Corbulomya*, than a *Corbula*; it is rather compressed and nearly equivalve.

23.—*C. obtusa* of the same author is also a sub-equivalve species, and more probably belongs to one of the sub-genera of *Neæra*, than to *Corbula*. Bosquet considers it to be a *Poromya*, (Foss. flora and fauna v. Limb., &c., in Staring's Bodem. v. Nederland).

24.—*C. ovalis* Pictet suggests to be a *Thracia*, but unless the original specimen be examined, nothing positive can be said of it. Morris does not even accept the species in his list of British fossils.

25.—*C. velata*, Schafhäutl, (Bayern's Leth. Geog., p. 176), may be a valve of a *Corbula*, but it would be labour in vain to theorize on that author's ideas of geological formations.

26-27.—*C. caudata*, Nillson, and *C. cometa*, Coq., belong to all appearance to *Neæra*, but the form which Goldfuss, (Petr. Germ., p. 251, pl. 151, fig. 17), describes and figures as a species identical with *C. caudata* of Nillson is certainly quite a different one.

28-29.—Conrad describes from Palestine, in the official report of Lynch's Expedition, *C. sublineolata* and *syriaca*. Fraas (Würtemb. Jahresh. xxiii, 1867, p. 236), considers the former as identical with *C. striatula*, Sow. The same author also states that Conrad's *C. congesta*, which is said to have been without any reason referred to the jurassic period, is based upon a cast not admitting of specific determination. I have, I am sorry to say, not as yet been able to get access to Conrad's "official report."

30-40.—Meek in his Check-list of Inverteb. cretaceous fossils of North America (Smiths. Misc. Coll., No. 177, 1864,) quotes *Corb. crassimarginata*, *crassiplicata*, *Eufalensis*, *Foulkei*, *Graysonensis*, *Hillgardii*, *inornata*, *occidentalis*, *subcompressa*, *Tuomeyi*, and *Corbulamella gregarea*. I have not been able to ascertain whether Gabb's *C. sub-caudata* is to be retained as an independent species.

41-46. In the Palæont. of California (vol. i and vol. ii, p. 233, &c.) Gabb describes—*C. primorsa*, *C. Traskii*, *cultriformis*, *parilis*, *Hornii*, and *alæformis*. The last but one species may prove to be a *Corbulomya*, and the first is also posteriorly peculiarly pointed, but it may be only a young valve of a *Corbula*.

47-48.—*C. Chilensis*, from Chili, and *C. Columbiana*, from Columbia.

49-53.—From India I shall have to add the following five species; *C. striatuloides*, *parsura*, *cancellifera*, *minima*, and *exulans*; the three first belong to the Trichinopoly, the fourth to the Arrialore, and the fifth to the Ootatoor group.

NEÆRA.

54-57.—Pictet and Campiche quote in the "Paléontologie Suisse" *N. Sabaudiana*, *Sanctæ-crucis*, *caudata*, and *Quillanensis*, to which *N. cometa*, (*Corbula* apud Coquand, Monog. Étage Aptien, 1865, p. 102,) has most likely to be added.

57a.—*Neæra brevirostris*, Alth, sp. (*Nucula id.*, Alth) is described from the upper cretaceous deposits near Lemberg (Desc. des Moll. foss. de la craie des ... Lemberg, &c., par E. Favre, Genève 1869, p. 103).

58.—Bosquet (in Staring's Bodem v. Nederland) names a *Neæra longicauda*, but I have not yet met with the description of the species.

Eichwald (Leth. ross., 1867, xi livr., p. 743,) describes from "grès verts" near Orenbourg a *Neæra tenuis*, but the shell has evidently nothing to do with that genus; it is either a *Leptomya*,

or perhaps more probably a *Cryptomya*, in which case it would be the first species of the genus from cretaceous rocks.

59-64.—Meek (Smiths. Misc. Coll., No. 177,) quotes from North America *N. alæformis*, *fibrosa*, *Moreauensis* and *ventricosa*, and Gabb described *N. dolabræformis* (Pal. California, i, 1864, p. 153).

65-66.—Two species occur in our South Indian cretaceous deposits, *N. mutua* and *detecta*, the last of which has some resemblance to *Corb. striatula*, but its shell, of which traces are present, is very thin. The first species is from the Trichinopoly, the second from the Ootatoor group.

POROMYA.

67-69.—I am acquainted for the present only with the three Indian species, *P. globulosa*, *lata*, and *superba* (see p. 47, &c.). The two former were, without any apparent reason, transferred by D'Orbigny to *Lyonsia*. Forbes also considered the *Corb. æquivalvis* of Goldfuss as a *Poromya*, but according to the hinge it does not belong to this genus, though the surface is partially provided with minute grooves. I shall describe it under *Pholadomya*, and state the necessary reason for this alteration subsequently.

Lutraria nukulæformis, Schafh., (Bayern's Leth. Geog., p. 175,) I would be inclined to consider as identical with our *P. globulosa*, at least the general form of both is the same. The form, figured by Schafhæutl, loc. cit., (pl. 41, fig. 2,) as *Corbula impressa* (1863, non *idem*, Eichwald Leth. Ross., liv. xi, 1867, p. 741,) is probably also a *Poromya*.

I am not certain whether Zittel's *Panop. frequens* from the Gosau (Denksch. Akad., Wien, 1865, xxiv, pt. ii, p. 111, pl. 1, fig. 5,) does not also belong to the present genus. The form and the general character of the shell are almost identical with those of our *P. lata*, but the hinge is very similar to that of a *Panopæa*, or rather to that of *Pleuromya*; it has, however, like *Poromya*, one tooth in each valve and posterior to it a groove, in which, in the last genus, the cartilage is situated. Whether that was the case with the species in question, Zittel's figure does not show clearly, for the tooth in the left valve is placed too much anteriorly, almost more so than that of the right valve, behind which it ought to fit when the valves are closed. The most important distinction to be observed in Zittel's figure, is the isolation of each of the teeth along the lower margin, while in *Poromya* the inner hinge area is thick, and the teeth and pits generally appear on it as projections and grooves. In specimens of our collection the hinge-teeth could unfortunately not be made visible, and the shell surface is also not well preserved.—I expect several of D'Orbigny's *Panopæa* will be shown to belong to *Poromya*; in some, like *P. inæquivalvis*, the author describes the granulation of the surface, similar to that of *Poromya*, but quite distinct from that of *Panopæa*.

I have already mentioned *Corbula obtusa*, which Bosquet considered to be a *Poromya*. *Ceromya recens*, *Pholadomya aptiensis*, and *fallax* described by Coquand in his Monograph of the Fossils of the Étage Aptien of Spain are more likely *Poromya* than *Ceromya*. I am also by no means certain whether such species as *Pholodomya Sanctæ-crucis*, or *Ph. Valangiensis* of Pictet and Campiche, ought not to be more correctly referred to *Poromya* than to *Pholadomya*.

Judging from external appearance and the imperfectly known hinge, I suppose *Corbula gigantea*, Sow., (Min. Conch., vol. iii, p. 13, pl. 209, figs. 5-7,) is also a *Poromya*. It very much resembles our *Por. superba*, differing from it by the anteriorly extended portion of the shell. The species has been placed by Morris in the genus *Thetis*, that author having considered Forbes' *Poromya* as identical with *Thetis*, which opinion is, as I have already stated, untenable. Pictet and Campiche (Pal. Suisse, 4th Ser., 3^{me} pt., p. 210,) are of opinion that the species probably belongs to a new genus; it is said to possess the same deep sinus, as *Thetis* has, but Sowerby does not say anything on this point; unless, therefore, Pictet and Campiche have examined fresh specimens, the question would still remain unsettled.

These are only a few of the most prominent instances indicating the occurrence of *Poromya* in a fossil state. I could add a much greater number of suggestions regarding the generic determination of the cretaceous species, but it would be hardly fair to go into these details without the examination

of the original materials. Some more species I shall have to mention when speaking of *Pholadomya* and *Panopæa*. It is to be hoped that the attention of palæontologists will be directed more to the genus *Poromya*, than has been hitherto the case, for it is really a very important genus among mesozoic Pelecypoda.

Under *Mya* a few species from cretaceous rocks have been described by older authors, but none of them have been proved to belong to that genus. The same is, strictly speaking, the case with jurassic and a few palæozoic species of the so-called *Myæ*, for their determination as yet only depends upon the external form, and seems in many cases a very doubtful one.

Thus we have in the cretaceous deposits *Corbula*, *Corbulamella*, *Næra*, *Poromya*, most probably *Corbulomya*, and possibly *Himella* represented; *Spheniopsis*, *Eucharis*, *Corburella*, and *Cryptomya* may be shown to occur; but no such forms as *Tugonia*, *Sphenia*, *Platyodon*, and even *Mya* are as yet distinctly indicated.

CORBULA, Brug., 1792, (see p. 35).

✓ 1. CORBULA STRIATULOIDES, Forbes, Pl. XVI, Figs. 13-14.

1846. *C. striatuloides*, Forb., Trans., Geol. Soc., Lond., VII, p. 141, pl. 18, fig. 14—*idem*, auctorum.

1847. ? *C. cochlearia*, d'Orbigny, Pal. of the voy. de l' Astrolabe, pl. 5, figs. 14-17.

C. testa oblonga, postice breviter ac rectiuscule caudata, crassa, convexa, umbonibus incurvis, fere centraliter sitis instructa; valvula dextra majori, postice oblique carinata, concentrice confertim striata; valvula sinistra minori, prope peripheriam striis crassiusculis prædita.

Height of the larger valve :	its length	...	...	...	0.66
Thickness of shell	:	„	...	...	0.44

The solid structure, the great convexity of the right valve, and its short posterior prolongation readily distinguish this species from the European *C. striatula*, and the small height from *C. sub-striatula*. The right valve is much more solid than the left one; it also has the margins strongly bent in towards the latter, which is thinner, considerably smaller, but a little more coarsely striated than the right one. The species is very much like the recent *C. sulcata*, Lam., from Senegal.

D'Orbigny's *C. cochlearia* is most probably the same species as *C. striatuloides*, though the figures do not correspond very well. The coarser striation of the left valve is distinctly shown; but the right valve of *striatuloides* is finely striated, while D'Orbigny's figure represents it equally, or even more coarsely striated than that of the left valve; no such form occurs in our collection of the South Indian cretaceous fossils.

Locality.—In a light coloured sandstone south of Koloture; rare. A similar but flatter species occurs in the soft sandstones at Streepermatoor, but the specimens are not sufficient for characterizing the species.

Formation.—Trichinopoly group.

✓ 2. CORBULA PARSURA, *Stoliczka*, Pl. I, Figs. 23-24, and Pl. XVI, Figs. 3-4.

C. testa sub-quadrangulari, alta, postice hiante; valvula dextra multo majore quam sinistra, inæquilaterali, convexa, umbone obtuso, prominulo et incurvo instructa, antice sub-rotundata, postice truncata, breviter caudata, ad marginem elevata, in superficie concentrice crasse costulata; valvula sinistra ovulata, dextrâ multo minori, antice rotundata, postice angustata atque obtusiuscula, in superficie fere lævi, umbone leviter incurvo, acutulo; cardine dentibus ac fossis, sicut in Corbulis typicis, instructo.

Height of the right valve	:	its length	...	...	...	0.83
„ of the shell	:	„	...	...	...	0.58

The two valves of this species are remarkably unlike each other in size and ornamentation, the right being much the larger, subcaudate posteriorly, and concentrically strongly ribbed; the left is very small, slightly convex, tightly fitting in the other, and nearly smooth. Viewed from the right valve the shell greatly resembles a *Mya*, indicating a wide posterior gape. The right valve has, as usual, a deep cartilage-pit and one large tooth in front of it, the left valve a posterior cartilage process and an anterior pit. The posterior muscular impression is in the right valve rounded, large; the pallial impression very slightly insinuated.

The largest specimen observed measures 6 m.m., but it seems rarely to grow to that size.

Locality.—In bluish highly calcareous shelly sandstone at Garudamungalum.

Formation.—Trichinopoly group.

✓ 3. CORBULA MINIMA, *d'Orbigny*, Pl. I, Figs. 19-22, and Pl. XVI, Figs. 7-12.

1847. *C. minima*, d'Orb., Pal. de la voy. Astrolabe et Zélée, pl. 5, figs. 18-19.

C. testa oblonga, sub-equilaterali, antice ac postice subangulata, clausa, umbonibus prominulis, fere medianis, antice versus incurvis, superficie striis minutis induta; valva dextra paulo majori quam sinistra, in utraque carina acutiuscula ab umbone ad terminationem posteriorem decurrente instructa.

Height of shell (pl. xvi, fig. 7)	:	its length	...	...	...	0.68
Thickness „	:	„	...	...	...	0.51

The valves are in this species subequal, the right one being a little larger than the left, the umbones are subcentral, and incurved towards the front; both are equally finely and concentrically striated, and a sharp carina runs from the umbones towards the posterior end, which is somewhat produced and attenuated; from the carina the shell slopes to the postero-superior margin; both valves are perfectly closed at their terminations. The hinge is identical with that of recent *Corbulæ*, the tooth in the right valve and the process in the left being, as compared with the size of the shell, rather small. The species rarely seems to grow larger than 4 m.m., which was the greatest size observed among many specimens.

D'Orbigny's figure is probably a little too high, but there are specimens in our collection which are almost identical with it in form. The most important variations are sufficiently illustrated on plate xvi.

Locality.—In dark brown sandy and cherty limestone; north of Odium; not rare.

Formation.—Ootatoor group.

✓ 4. CORBULA CANCELLIFERA, *Stoliczka*, Pl. I, Fig. 17; Pl. XVI, Fig. 2.

C. valvula sinistra sub-triangulari, antice sub-rotundata, ad marginem inflexa, postice angustata ac acuminata, umbone sub-antico, mediocriter prominente, obtuso, antice versus incurvo, carina acuta ab eo ad terminationem posteriorem rectiuscule decurrente instructa; superficie striis concentricis distantioribus, acutis, ac alteris radiantibus, minutissimis ornata.

Height of left valve	:	its length	...	...	...	0.67
Probable thickness of the shell	:	"	...	...	...	0.47

The ornamentation of this species is very peculiar and distinct from that of any other known cretaceous species; it approaches, however, in this point as well as in its form to some of the recent species, like *C. tunicata*, Hinds, and others. The concentric striæ are distant and very sharp, and the radiating lines are very fine and close together; they are better visible in the grooves than on the striæ themselves; the posterior carina is slightly curved, it is especially sharp and prominent near the end; the margin of the shell is anteriorly strongly inflected, very similar to that of *C. exulans* n. sp.; the recent species rarely have this inflection equally strong.

Locality.—In bluish, compact calcareous sandstone near Garudamungalum, in company with *C. parsura*, and a large number of little *CARDIIDÆ*, *VENERIDÆ*, &c.

Formation.—Trichinopoly group.

✓ 5. CORBULA EXULANS, *Stoliczka*, Pl. I, Figs. 16 and 18; Pl. XVI, Figs. 1 and 5.

C. testa sub-trigona, alta, crassa, compressiuscula, fere æquilaterali, antice sub-rotundata, postice angustata et sub-acuta, concentricè striata; umbonibus adpressis, obtusis, parum incurvis; carina ab umbonibus ad terminationem posteriorem decurrente prope marginem sita, mediocriter prominente; valvula dextra sinistra paulo majori.

Height of shell	:	its length	...	...	...	0.76
Thickness	:	"	...	...	...	0.52

This is a peculiarly triangular, high, nearly equilateral thick shell, laterally much compressed, rounded in front and rather acutely angular posteriorly; the right valve is somewhat larger than the left one, both being perfectly closed round their margins and inflected towards each other; the entire surface is finely striated.

The beaks are obtuse, incurved, and close together. The tooth in the right valve is large, but the hinge does not differ in any other respect from that of typical *Corbulæ*.

Locality.—In a light greyish or yellowish sandstone about 5 miles south of Arrialoor.

Formation.—Arrialoor group.

NEÆRA, *Gray*, 1834, (see p. 37).

✓ 1. NEÆRA MUTUA, *Stoliczka*, Pl. III, Fig. 6; Pl. XVI, Fig. 6.

N. valvula dextra globosa, longiori quam alta, antice rotundata, postice caudata, pertenui, fere hyalina, concentric striis incrementi minutissimis tecta ac confertim puncturata; umbone prominulo, antice versus incurvo.

Height of the right valve	:	its length	...	...	...	0.62
Thickness „ „	:	„	...	...	...	0.31

The very thin, almost hyaline, finely striated and punctured shell appears to be characteristic of this species; the beak is prominent, and strongly incurved towards the front; its sides are convex; the anterior termination is rounded, the posterior narrowly produced, and obtusely truncated at the end. The cartilage process is elongated, but narrow, and the tooth in front of it indicated by a slight thickening of the margin, which projects a little beyond the margin of the hinge.

Locality.—South of Parchairy, in a bluish sandstone; only the figured valve has been found.

Formation.—Trichinopoly group.

✓ 2. NEÆRA DETECTA, *Stoliczka*, Pl. III, Fig. 7; Pl. XVI, Fig. 15.

N. valvula sinistra sub-inflata, convexiuscula, tenui, antice rotundata, postice caudata, concentric striata; umbone postice versus incurvo, carina obtusiuscula ab eo oblique decurrente usque ad terminationem posteriorem rectiuscule prolongata.

Height of the left valve	:	its length	...	...	...	0.59
Thickness „ „	:	„	...	...	...	0.25

This species is much more depressed than the previous, and the beak is incurved in the opposite (posterior) direction; the concentric striæ are somewhat stronger anteriorly than posteriorly; the upper margin of the wing is slightly insinuated, its termination being bent upwards. The European *N. caudata* of Nillson is closely allied to the present form, but it has the posterior end still narrower and longer, and the beaks incurved in a direction perpendicular to the longitudinal axis of the shell.

Locality.—The single specimen was found in the yellow sandy limestone near Odium in company with *Turnus lapidosus*, *Turritiles Bergeri*, *Ammonites rostratus*, &c.

Formation.—Ootatoor group.

POROMYA, Forbes, 1844, (see p. 38).

✓ 1. POROMYA GLOBULOSA, Forbes, Pl. III, Fig. 8; Pl. XVI, Fig. 16.

1846. *P. globulosa*, Forbes, Trans., Geol. Soc., Lond., VII, p. 141, pl. 17, fig. 6.1850. *Lyonsia id.*, d'Orb., Prod. II, p. 234—*idem* auctorum.

P. testa inflata, inæquilaterali, tenui, antice rotundate truncata, postice paululum attenuata et producta, ad terminationem rotundata, concentrice minutissime striata ac radiatim punctata, punctis in seriebus radiantibus dispositis; umbonibus tumidis incurvis.

Height of shell	:	its length	...	...	...	...	0.89
Thickness	„	:	„	...	...	...	0.76

Shell strongly globular and short, with the beaks prominent and incurved; the anterior side is rather truncated, the posterior which is the longer one attenuated, compressed, and rounded. The hinge-teeth have not been observed; the punctuations are to be seen, as stated by Forbes, only on the well preserved surface, but when this is a little worn off they disappear altogether. These punctures are connected with very fine radiating lines. The beaks are slightly incurved towards the anterior end. Forbes' figure ought to be more inequilateral, anteriorly much shorter than posteriorly. In our fig. 8 on pl. 3, the striæ on the anterior side ought to be turned more upwards, as shown in the corrected fig. 16 on pl. xvi.

Locality.—In a light coloured sandstone near Comarapolliam; rare.

Formation.—Arriallor group.

✓ 2. POROMYA LATA, Forbes, Pl. II, Figs. 8-9, and Pl. XVI, Fig. 17.

1846. *Poromya lata*, Forbes, Trans., Geol. Soc., Lond., VII, p. 141, pl. 15, fig. 14.1850. *Lyonsia id.*, d'Orb., Prod. II, p. 234—*idem* auctorum.

P. testa oblonga, tenui, convexiuscula, inæquilatera, antice breviori; umbonibus prominulis, antice incurvatis; ad extremitates rotundata, in superficie polita, concentrice striata ac punctis distantibus, profundis, in lineis radiantibus paululum elevatis dispositis notata.

Height of shell	:	its length	...	...	...	...	0.74
Thickness	„	:	„	...	...	...	0.63

This species only differs from *P. globulosa* by its somewhat greater length and by the punctuations of the surface being larger and more distant; it may possibly be only a variety of the former, but there are only a few specimens of each form as yet known, and these do not allow a very critical comparison; they also do not occur on the same geological horizon. The posterior side of the present form is considerably longer than the anterior, and somewhat turned upwards at the termination; both ends are rounded. The shell is also very slightly

gaping posteriorly. The beaks are prominent and incurved towards the front. The hinge of the left valve is composed of two teeth, the anterior of which is much larger than the posterior, which very probably supported the cartilage (see pl. xvi, fig. 17*); the fulcra for the ligament are small.

Locality.—In bluish calcareous sandstone at Garudamungalum and at Pondicherry.

Formation.—Trichinopoly group, (? Valudayur group).

✓ 3. POROMYA SUPERBA, *Stoliczka*, Pl. III, Figs. 2-4.

P. testa oblonga, crassa, tumida, postice hianti, valde inæquilaterali, antice abrupte declivi et subrotundata, postice producta, subtruncata; umbonibus prominentibus, latis, antice versus paulo incurvis; superficie costulis ac striis incrementi concentricis, et multis lineis elevatis radiantibus spinulose tuberculatis, sed in parte postica sub-obsoletis ornata; costulis concentricis prope umbones sitis precipue distinctis, latis ac æqualibus. Cardo in utraque valva dentibus duobus instructus; in valva sinistra dens posticus, in dextra dens anticus, altero major.

Height of the right valve	:	its length	...	...	...	0.69
Thickness	„	„	:	„	...	0.32

This is a gigantic but typical species of *Poromya*, the shell is very globose, inequilateral, the posterior side being much longer and subtruncate at the end; the anterior side is rather abruptly sloping and narrowly rounded. The surface is covered with concentric lines and ribs, which are strongest and most prominent near the umbones; besides that there are numerous radiating lines provided with small spiny tubercles, where they meet the former. When the spines are broken off small grooves appear in their place. This is exactly the structure of the shell of the recent *Poromyæ*, and it is probable that the punctures which have been described in the two previous species are only due to the removal of the spines.

The hinge is composed of two teeth in each valve, and the fulcra are very strong and prominent. In the left valve there is a rounded tooth in front, with a groove on either side: in the anterior groove a small tooth of the right valve fits in; in the posterior lies the cartilage supported by a long, almost horizontal, tooth of the opposite valve; the posterior tooth in the left valve is represented by an oblique ridge, but distinct from the fulcrum.

The largest specimen observed measures 130 m.m. in length and about 100 in height.

Locality.—In earthy and calcareous shelly sandstone near Garudamungalum, and in a conglomerate near Koloture.

Formation.—Trichinopoly group.

* In fig. 9 b on Pl. II the hinge-teeth and cartilage process are not sufficiently clearly drawn.

IV. *Family*,—*MACTRIDÆ*.

As far as the animals of the species, belonging to this family, have been examined, they all have been shown to possess united siphons and a more or less prolonged, laterally compressed and pointed foot; the palpi, or labial appendages, are four in number, long, narrow and pointed; the gills are not prolonged in the siphons; the mantle margins are widely open in front and narrowly behind, sometimes serrated at the free edges.

The shells are, as a rule, equivalve and of moderate thickness; the hinge has a large cartilage-pit in each valve, one triangular or prominent short tooth in front of it and a much thinner and generally more elongated one posterior to it; the lateral teeth when present are simple in the left, and double in the right, valve; the pallial impression is variable, rarely entire, but generally distinctly sinuated posteriorly.

Though the shells of the *MACTRIDÆ* exhibit a large amount of variation, they all evidently belong to one and the same type, the cartilage-pit and the anterior short triangular-shaped tooth being found in all of them, only exceptionally they are not so well developed as seen in the typical species of *Mactra* and others.

At the same time two somewhat different groups, or sub-families, can certainly be conveniently separated, as pointed out by H. and A. Adams, Gray, Conrad, and others. The one has for type the genus *Lutraria*, the second *Mactra*. In the former, the *LUTRARIINÆ*, the shells are usually elongated, the lateral teeth of the hinge are either obsolete, or very small, and the animals have long united siphons more or less protected with an extension of the epidermis which covers the entire shell. This sub-family exhibits in its typical forms, as for instance *Tresus* and *Lutraria*, the greatest resemblance to *Mya*, with which it has been, and is often now (Römer) classed in one and the same family. The animals and shells are externally almost identical in both. For these reasons I prefer, therefore, to class the whole of the *MACTRIDÆ* next to the *MYIDÆ*, instead of following H. and A. Adams who place them in the *VENERACEA*.

The *MACTRINÆ* generally have a more equilateral, sub-triangular shell, the hinge with the lateral teeth well developed, and the animals possess short siphons covered only at their base with the epidermis of the shell. Thus, as compared with the *MYIDÆ*, the present two sub-families, *MACTRINÆ* and *LUTRARIINÆ*, may be said to be analogous to *CORBULINÆ* and *MYINÆ*, the divisions being based respectively on perfectly similar characters.

A list of the recent species of the *MACTRIDÆ* has been published by Mr. T. A. Conrad in pt. 3, vol. iii of the Amer. Journal of Conchology.

I might also have placed near this family the *CRASSATELLIDÆ*,—at least the genus *Crassatella*,—but their animals are so closely allied to those of *Astarte*, that the presence of an internal cartilage cannot be accepted as a character, decisive in point of classification, entirely superseding all others.

Considering palæontological evidence the *MACTRIDÆ* would appear to take a high place in the system, and the division of the two sub-families also appears to

be distinctly indicated. The *LUTRARIINÆ* are, like the *MYINÆ*, only known from cainozoic deposits, a great number of the miocene forms being very similar to, or identical with, recent species. Already in the lower tertiary, or eocene, beds the presence of their species is doubtful, with the exception of the forms designated by Conrad *Pteropsis*.

There have been species described under the name of *Lutraria* from cretaceous, jurassic, and by McCoy even from carboniferous strata; but the generic determination is by no means certain; it was based merely upon external resemblance; and the jurassic species, so called, have already been sufficiently proved not to belong to the *LUTRARIINÆ* at all, being mostly species of various genera of the *ANATINIDÆ*.

Of the *MACTRINÆ* there are about 50 tertiary species well known, and typical species, though very few, of this sub-family certainly occur in cretaceous beds, but those from older formations are as yet doubtful; at least the hinges of none of those described from jurassic and older deposits are known, and the external form is, as in the previous case, not to be depended upon as a point of reliable generic determination.

On account of this scarcity of species in a fossil state I shall have but few genera to record in addition to those which are treated of in most of the larger conchological works. The generic divisions, mostly introduced by Dr. Gray, are, however, in several instances based upon too minute distinctions, and require some alterations. I am by no means certain whether it is at all necessary to distinguish some of them even by a separate sub-generic name, as I shall state subsequently.

a. *Sub-family*,—*LUTRARIINÆ*.

The arrangement of the genera of this sub-family will be 1st, according to the prevalent development of the cardinal teeth next to the cartilage-pit, 2nd, to that of the laterals, and so on.

1. *Anatinella*, Sow., 1829. Shell oval, posteriorly somewhat produced and gaping; hinge with a long, oblique, posteriorly directed spoon-shaped process in each valve for the reception of the cartilage; next to the cardinal process there are two teeth on each side in the right valve, in the left valve there is a bifid tooth in front next to the margin of the process, and a very indistinct posterior one near the upper margin; lateral teeth obsolete, a very short external ligament just behind the beaks is also present, pallial impression entire, anterior muscular impression elongated, marginal, posterior roundish.

Anatinella is in many respects allied to *Tugonia*; it has a similar form, a cartilage process in each valve, a simple pallial line, etc., but it has unquestionably the distinctive character of the *LUTRARIINÆ*, possessing similar small teeth next to the cartilage process as seen in *Lutraria*. It is, so to say, equally related to *Tresus* as is *Tugonia* to *Platyodon* or *Mya*, but until the animals are known the systematic position of both the genera must remain somewhat unsettled.

2. *Cardilia*, Deshayes, 1835. Shell ovate, higher than long, tumid, with the beaks prominent and incurved anteriorly; hinge with a large cartilage-pit in each valve; two cardinal teeth in the left and one in the right valve, one posterior marginal lamella projects into the space internally on which the muscular impression is situated, pallial line simple.

In external appearance, especially in the peculiar radiating striæ on the posterior half of the shell, this genus again recalls *Tugonia*, but it is not gaping posteriorly, and the internal, lateral lamellar tooth seems to be very characteristic. Deshayes's classification of the genus next to *Heterocardia* certainly appears more correct than that of some other authors who place it near *Glossus*, (*Isocardia*, auctorum) on account of the external resemblance of both.

3. *Strothodon*, Giebel, 1856, (Abhandlg. des Nat. Ver. f. Sachsen und Thüringen, I, pt. 1, p. 102). Right valve tumid, high like *Cardilia*, beaks incurved, with a groove running from the beaks to the posterior margin, hinge with a flat cardinal tooth and with a second tooth projecting from its base below and anteriorly. Only one valve (*St. Liscaviensis*), is known of this shell from the triassic beds of Liskau (Germany). It has the general appearance of a *Cardilia*, but the hinge differs, and as the teeth are flat, I suspect that at least the upper one indicates by its form that it had supported a cartilage. Giebel says that an external ligament is also present, but it must have been rather thin, for the fulcra are not perceptibly thickened. In general appearance the shell bears also a great resemblance to *Cryptodon* and to some species of *Lucina*, represented by the type *L. columbella*.

4. *Heterocardia*, Desh., 1854. Shell subtrigonal, or transversally oval; cartilage-pit wide, short, cardinal teeth thin, prominent; anterior lateral very close to the cardinal, short; posterior, elongated; pallial sinus very deep.

5. *Darina*, Gray, 1849. Shell oblong, rather compressed and slightly gaping at both ends, umbones sub-central; hinge with a large cartilage-pit, lateral teeth very close to the cardinal, anterior shorter than the posterior; ligament external, separated from the cartilage by a shelly plate.

6. *Cæcella*, Gray, 1849. Similarly oval as the last, anterior cardinal tooth of left valve thick, and grooved at the end, the posterior cardinal and the two teeth of the right valve very slightly prominent; lateral teeth elongated, almost equal, close to the cardinal and diverging; ligament marginal, internally not separated from the cartilage.

There are several species of this genus in the eastern seas, some of them appear to be estuary, or at least partially so. I am not certain whether *Darina* is really generically different from the present genus; either of them may be considered as a sub-genus of the other.

7. *Raëta*, Gray, 1849. Shell thin, ventricose, high, slightly produced posteriorly and gaping; cardinal teeth strong, the anterior much shorter than the posterior; lateral teeth thin, but distinct, close to the cardinal, highly diverging from the beaks; ligament marginal, situated in a deep groove but free above. The thin, concentrically plicated shell is very characteristic for these forms, which are probably estuary.

8. *Labiosa*, Schmidt, 1832. Shell thin, similar to the last, with a sharp rib running from the beaks to the infero-posterior margin; anterior lateral tooth less oblique than in the last genus, in other respects the hinge is very similar in both; and it would probably be better to consider this only as a sub-genus of the former.

9. *Vanganella*, Gray, 1849. Shell oblong, rather compressed, beaks sub-central, with two ribs diverging from them internally; hinge with the cartilage-pit large, produced obliquely towards the anterior rib, the posterior cardinal tooth of the left valve folded together, of the right valve small and separate; lateral teeth small, close to the cartilage process; ligament marginal, not perfectly separated from the cartilage.

This genus is based upon a remarkable recent species, *V. Taylorii*, Gray. The anterior internal rib is quite similar to that of the fossil *Machomya* (*vide postea*), the hinge of which is, however, not known. Agassiz figured in his monograph of the fossil *Myæ* several species which may turn out to be *Vanganellæ*. I allude specially to such forms as *Mactromya mactroides* or *M. Couloni*.

10. *Zenatia*, Gray, 1849. Shell oblong, compressed, upper and lower margins subparallel, umbones anterior; posterior gape wide; cartilage-pit large; cardinal teeth prominent, anterior lateral tooth in the left valve rather distinct, posterior laterals quite close and almost confluent with the upper edge of the shell; ligament sub-marginal, not separated from the cartilage.

11. *Pteropsis*, Conrad. I am only acquainted with this generic form from the check-list of inv. foss. of N. America, (eocene and oligocene), Smithsonian. Misc. Coll., No. 200, 1866, p. 8. Two species, *Pt. papyria* and *lapidosa*, are described from eocene beds.

12. *Tresus*, Gray, 1849. Shell oval, solid, externally perfectly similar to that of *Mya*, widely gaping posteriorly; hinge with a wide cartilage process, very short cardinal teeth, and the lateral teeth small and situated near the cartilage-pit; ligament external, marginal; pallial sinus very deep. The only species *T. maximus* is from California.

13. *Schizothærus*, Conrad, 1852 (Proc. Acad. N. S. Phil., p. 199). Is very closely allied to *Tresus* with a deep channel on either side of the cardinal teeth. The figure of the species, *Sch. (Cryptodon) Nuttallii*, given on pl. 18 of vol. vii., Journ. Acad. Nat. Sci. Phil., 1837, indicates the presence of very thin anterior lateral teeth. The terminations of the siphons of *Schizothærus* are protected by two solid valves, which I am not aware of having been noticed in *Tresus*. In every other respect both genera could be very easily identified. The fossil species, *Schizothærus Nutalli*,* Conrad, described in vol. V of Reports of expl. and surveys to ascertain the ... route for a railroad, &c., p. 324, pl. iv, fig. 33, is considered by Gabb to be the same species (Pal. Calif., vol. II, p. 91), but it shows no trace of lateral teeth. Unless this is explained by a change of age, in which case the latter would be a full grown form of the former one, I cannot see the reason for the identification.

* I do not know exactly which the proper spelling of the two words is; they are almost in every instance, referred to, written in a different way by American authors themselves.

14. *Lutraria*, Lamarck, 1799. Shell oval, rather compressed, posterior gape moderate, cardinal teeth small, anterior lateral elongated, prominent, posterior obsolete, or nearly so; ligament attached on the inner side of the margin just behind the beaks, not much visible externally; pallial sinus deep.

15. *Standella*, Gray, 1837. Shell ovate, slightly tumid, hinge with the lateral teeth very close to the cartilage-pit thin, obliquely diverging, ligament sub-external, marginal, not distinctly separated from the cartilage. This is by no means equally distinct from *Lutraria*, as is, for instance, *Zenatia* or *Vanganella*, and may better be regarded only as a sub-genus of the former.

15a. The species separated under the sub-generic name of *Merope*, H. and A. Adams, have a somewhat thinner shell and a radiately striated or ribbed surface; these ribbed species form a transition to the next.

15b. *Mactromeris*. Conrad refers to this sub-genus *Standella ovalis*, Gould, *St. ovata*, Gray, and five others (see Cat. of *MACTRIDÆ*, in vol. iii. of the Amer. Jour. of Conchology, p. 45).

16. *Eastonia*, Gray, 1849. Shell oval, ventricose, thick, radiately ribbed; hinge with the cardinal teeth of the left valve thin, laminar, narrowly notched; anterior lateral nearly perpendicular, and in front of it, or rather in its horizontal prolongation, there is another small tooth present; posterior lateral teeth long; ligament sub-external, not separated from the cartilage, supported in the right valve by a distinct rib.

The tertiary fossil form, which has been identified with the only recent species, *E. rugosa*, Chem., has the groove and small tooth in front of the anterior lateral tooth very distinct, and the cardinal tooth not very strong (see Hörnes, fossile Moll. des Tertiär-beckens, Wien, vol. ii, pl. 5, fig. 4). The posterior lateral is specially long and very much approaches that of the *MACTRINÆ*.

b. Sub-family,—*MACTRINÆ*.

The arrangement of the genera is according to the size of the lateral teeth.

17. *Harvella*, Gray, 1849. Shell sub-trigonal, rather thin, posterior slope keeled; cardinal teeth small, lateral teeth close to the cardinal, short; hinge margin double, ligament marginal, separated from the cartilage by a shelly lamina. The only species is *H. elegans* from Florida. The two following sub-genera agree in form of the shell with *Harvella*, but show slight distinctions in the form of the hinge-teeth.

17a. *Mactrella*, Gray, 1849. Shell rather long, hinge with the hinder lateral teeth very small, sometimes almost obsolete, anterior distinct and distant from the small cardinal. The type of the genus is *Mact. alata*, Spengler, or *M. carinata*, Lam.

17b. *Mactrinula*, Gray, 1849. Shell with the cardinal teeth short, lateral close to them, but much more elongated than in the last. The species of *Mactrinula* can only be considered as slightly differing from *Harvella*; there is no sufficiently

distinctive character by which they could be generically separated. H. and A. Adams quote *Blainvillia*, Hupé, 1854, (non *idem* Robineau-Desvoidy, 1830,) as identical with *Macrinula*. Chenu, however, considers *Blainvillia* as a distinct genus, which externally appears to me to be very similar to *Clementia*, particularly looking at the species which he figures as *Bl. vitrea*, Hupé. In any case if that shell really belongs to the *MACTRINÆ*, and is sufficiently different from *Macrinula* and *Harvella*, it must receive a new name.

18. *Cymbophora*, Gabb, 1869, (Pal. Calif., vol. II, p. 180), proposed for *Mactra Ashburnerii* a cretaceous species. Form typical as in *Mactra*, but "the hinge is composed of a rather heavy hinge-plate, bearing a cartilage-pit, not sunk into its substance, as in other genera of the *MACTRIDÆ*, but, as it were, built upon its surface; a small delicate spoon-shaped process laid obliquely under the beaks, its base being on, or slightly above, the level of the hinge-plate; in the right valve the cardinal tooth is single, very delicate, and nearly at a right angle with the anterior wall of the cartilage-pit; in the left valve the tooth is \wedge -shaped, entirely separated from the pit, very slender, and articulates between the tooth and the pit of the opposite side; the lateral teeth are large and comparatively very robust." The cartilage-pit is certainly peculiar (? natural), but whether this is sufficient reason for a generic separation seems to me doubtful.

19. *Spisula*, Gray, 1837, (*Hemimacra*, Swains., 1840). Shell sub-trigonal; cardinal teeth short, strongly elevated and emarginated in the left valve, small in the right one; lateral teeth diverging, long, cross-ribbed; single in the left, double in the right valve; ligament marginal, not separated from it by a shelly ridge; pallial sinus moderately deep and horizontal.

19a. The more elongated triangular forms were called by Mörch *Oxyperas*, like *Sp. (Oxyp.) triangularis*, Lam.

20. *Mactra*, Linn., 1767 (*Trigonella* apud H. and A. Adams). Shell trigonal, anterior cardinal tooth in the left valve strong, in the right smaller, lateral teeth long, considerably raised in the middle; ligament separated from the cartilage-pit by a shelly ridge; pallial sinus moderate, roundish or sub-angular. The two following divisions may be considered as sub-genera of *Mactra*.

20a. *Schizodesma*, Gray, 1837, (*Trigonella*, daCosta, auctorum,) has been proposed for two species, *M. Spengleri* and *nitida*, which only differ from typical *Mactræ* by not having the ligament distinctly separated from the cartilage, but this character does not appear very constant.

21. *Mulinia*, Gray, 1836. The cardinal teeth are in both valves strong, and the ligament is almost quite internal, attached to the inner edge of the margin, just above the cartilage, from which it is not separated by a shelly plate.

22. *Pseudocardium*, Gabb, 1866, (Palæont. of Calif., vol. ii, Sect. i, pt. i, p. 20). "Shell thick, heavy, equivalve, resembling *Lavicardium* externally, ligament internal, lunule cordate, deeply impressed. Hinge composed of a large cartilage-pit, and in the left valve of a \wedge -shaped tooth articulating in a corresponding depression on the opposite valve; two lateral teeth in each valve very large and promi-

ment; these teeth are comparatively narrow in the young shells, but in adult specimens attain an unusually large size; pallial line unknown." Type *Ps. Gabbii*, Rém. sp., from tertiary deposits of California. There is a cretaceous species described by Müller as *Cardium Nöggerathii*. Its hinge strongly reminds one of Gabb's *Pseudocardium*, but I have as yet only seen the hinge of the right valve, and this is not sufficient for a correct generic determination.

23. *Mactrodesma*, Conrad, 1868, (Amer. Journ. Conch., vol. IV, p. 247). Shell sub-triangular, solid; cartilage-pit very large, projecting much beyond the lower margin of the hinge; anterior hinge-margin of right valve thick and continued much beyond the beak; hinge of left valve with a strong \wedge -shaped cardinal tooth; lateral teeth short, thick, sub-equal; pallial sinus narrow and deeper than in *Mactra*, but extending as far as the cartilage-pit; muscular scars very large. Type *Mactra ponderosa*, Conrad, (Fossils tert. format., 1838, p. 25, pl. 14, fig. 1), from the miocene beds of Maryland.

24. *Rangia*, Desmoul., 1832. Shell sub-triangular, thick, covered with a brown epidermis; hinge with two teeth in each valve, the front one of left valve larger and bifid; lateral teeth elongated, transversally striated, ligament internal, situated at the upper edge of the cartilage-pit; pallial sinus short. This is the brackish representant of the *MACTRINÆ*; the shell externally greatly resembles some species of *Unio*. The oldest species of *Rangia* appears to be one noticed by Dunker from the Wealden deposits, as *Gnathodon Valdensis*, (Wealden-bildungen, p. 57).

24a.* *Rangianella*, Conrad, 1867 (Amer. Journ. Conch., vol. iii, App. p. 30,) is characterized by "lateral teeth, straight, sub-equal, not elongated, entire;" the only species is *R. trigona*, Petit.

LIST OF CRETACEOUS SPECIES.

LUTRARIINÆ.

For the correction of those species which have been described from cretaceous rocks under the generic name of *Lutraria*, see Pictet's Pal. Suisse, IV^{me} Ser., 3^{me} pt., p. 126. Not a single one of those species has been shown to belong to this sub-family. Gabb (Palæont. of Calif., 1864, vol. 1, p. 154), describes and figures a *Lutraria truncata*, which appears to me to be rather a *Spisula* than a *Lutraria*.

The four species, *Lutraria speciosa*, *cuneata*, *navalis* and *longissima*, (Schafhäutl's Bayern's Leth. geog., p. 172 et.) are not *Lutraria*, but either *Homomya* or *Panopæa*.

MACTRINÆ.

Of most of the European species quoted by Pictet and Campiche (l. c., p. 128, &c.) under the genus *Mactra*, the determination has been made from external appearance only, and in many cases it still requires confirmation. The species are—

1-7.—*M. Matronensis*, *Valangiensis*, *Carteroni*, *gaultina*, *sub-striata*, *angulata*, *porrecta*.

* Meek (Smiths. Misc. Coll., No. 183, p. 11,) also quotes a sub-genus *Perissodon*.

8.—To this, *M. Debeyana* (*Card. Debeyanum*, Müller,) has to be added (see Bosquet in Staring's *Bodem-van Nederland*, ii deel). I have examined a specimen obtained from Dr. Bosquet himself, and it shows the species to belong to *Schizodesma*, a sub-genus of *Mactra*.

9.—To the same sub-genus also belongs the Aachen species which Müller and Bosquet identify with Sowerby's *Mactra angulata*. It is, however, undoubtedly distinct from it, much longer and proportionately flatter, the posterior side shorter and rounded, the anterior longer and angular. It much resembles our Indian *M. tripartita*, which, as regards form, also differs from Sowerby's *M. angulata* as well as by a posterior ridge and stronger concentric ribbing. I propose to call the Aachen species *M. Bosquetiana*; it belongs to the sub-genus *Schizodesma*.

10-11.—*M. Didonis* and *Mavusi* of Coquand are from Algiers; they are rather globose, like *Poromya*; the hinges are not known.

12-17.—From North America Meek in his Check List (Smith. Misc. Coll., No. 177, 1864,) quoted the following species, *M. lata*, *formosa*, *gracilis*, *siouxensis*, *texana* and *Warrenana*.

18.—Gabb (Pal. Calif., 1864, I, p. 153,) describes *M. (Cymbophora) Ashburnerii*. Mr. Gabb says this "is one of the most common fossils in the state." *Mactra albaria* (Check List, &c., Smithsonian. Misc. Coll., No. 200, 1866, p. 8,) from the so-called lower eocene rocks will probably be added to the list.

19.—*M. Araucana*, d'Orb. (Voy. Astrolabe, Pal., pl. II, figs. 2-4,) is, as to external form, a typical species of a *Mactrella*.

? 20-21.—*M. Araucana* and *Cecileana* are first described by d'Orbigny (Voy. Ameriq. merid., pp. 125 and 126, pl. XV, figs. 3-6,) as coming from tertiary deposits of the island Quiriquina. With these two he also describes (ibid. p. 125) a *M. Auca* from Coquimbo north of Chili. This last species I would rather consider as a *Periploma* or a *Corimya*. The first named two are subsequently placed by the same author (Prod. II, p. 235,) in the Senonien, which, judging from the other species occurring with them, appears to be quite correct. M. d'Orbigny does not, however, state whether he considers the Astrolabe *M. Araucana* to be the same as that described in the Voy. Am. merid. The figures, if correct, would indicate two distinct species, the second having the shorter (posterior?) side roundish, and the longer (anterior) subcarinated, while the opposite is the case in the former.

22.—*M. Chilensis*, Gabb, is also from Chili.

23-26.—*M. petrosa*, *pervetus*, *arciformis*, and *syriaca* are described by Conrad in the official report of Lynch's expedition to Palestine. They are only based upon casts, and therefore doubtful as to generic and, if Fraas be correct, even as to specific determination.

27.—*M. tripartita* is the only species from our South Indian cretaceous deposits, the *M. intersecta* (*Cardium idem*, apud Forbes), being to all appearance only a variety of the same, as I shall presently explain.

MACTRA, Linn., 1765.

If we were allowed to draw a conclusion from the three cretaceous species which unquestionably belong to *Mactra*, there is reason to state that the sub-genus *Schizodesma* is the most prevalent, a form which is also numerously represented in the present seas.

✓ *MACTRA* (*SCHIZODESMA*) *TRIPARTITA*, Sowerby, sp., Pl. V, Figs. 8-11.

1846. *Mactra tripartita*, Sow., MSS., apud Forbes, Trans., Geol. Soc., Lond., 2 ser., VII, p. 142, pl. 15, fig. 17.
 „ *Cardium? intersectum*, Forbes, ibidem, p. 145, pl. 18, fig. 8.

M. testa subtrigona, margine inferiori moderate curvato instructa, subæquilaterali, parte posteriori paulo longiori quam antica; umbonibus acutis, antice versus incurvis, distantibus; superficie costulis, rotundatis vel in junioribus striis approximatis concentricis induta; declivitate antica ac postica striis pereminenter acutis ac distantioribus ornata, antica sulco angusto infra angulum lunularem sito, postica sulco multo latiori supra angulum arealem rotundatum sito separatis. Cardo regulariter sicut in speciebus recentibus formatus est, dente cardinali antico in valva sinistra fortasse crassiore.

			Fig. 8.	Fig. 9.
			Adult.	Young.
Height of shell to its length	...	...	... 0.76	... 0.77
Thickness	„	„	... 0.50	... 0.50

Young specimens of this species have the anterior side more angular and somewhat longer than the posterior; old grown specimens become, however, nearly equilateral. The distinction between the concentric thick ribs or striæ on the middle surface of the shell and the thin and sharp ones on the anterior and posterior declivities is very apparent and gave origin to the name of the species. The anterior declivity is separated from the outer or middle surface by a narrow groove situated below the angle which bounds the lunula; the posterior declivity forms with the middle, or lateral, part of the shell an obtuse angle, and this one is separated from the latter by a broadly shallow groove. As regards the form, I must remark that, as the edge of the anterior side is thinner than the posterior, it more easily wears away, and that on this account the valves sometimes appear more equilateral than they otherwise would be; fig. 9 *b* represents such a specimen which to all external appearance appears perfect, while it certainly is a good deal worn away on the front side.

The hinge is regularly formed, the cardinal tooth of the left valve is somewhat longer than in most of the recent species, the lateral teeth and corresponding grooves are of great length, and in both valves mostly prominent in the middle. The ligament lies marginally, just at the end of the cartilage-pit, from which it is not separated by a shelly lamina, the only character which distinguishes *Schizodesma* from true *Mactra*.

Forbes' figure (quoted above) is not quite exact, the original specimen being longer than represented in that figure.

D'Orbigny was the first to suggest placing the form described by Forbes as *Cardium intersectum* under *Mactra*. I have examined Forbes' original, in 1867, and found the specimen very defective, but to all appearance a *Mactra*; it is only a little shorter than *M. tripartita*,—evidently from being a little worn off—; and as the ornamentation is in both the same, I was led to consider both as belonging to one

and the same species. It is always difficult to give a decided opinion on specimens which are imperfect, but my suggestion as to their identification is strengthened by our specimens, which certainly are Forbes' *M. tripartita*, and appear to be from the same locality as the specimen named by Forbes' *Cardium intersectum*; at least the yellowish brown calcareous rock is in both cases the same. There is no better conclusion to be derived from Forbes' original, and we should only be justified in recognizing it as distinct upon the discovery of well preserved specimens which agree with it in form better than with *M. tripartita*; taking, however, our present materials as a basis, such forms as represented in figure 9b (pl. V) cannot be acknowledged as independent species.

Locality.—About two miles north of Alundanapooram and three miles south of Serdamungalum; apparently not common.

Formation.—Trichinopoly group.

V. *Family*,—*ANATINIDÆ*.

As regards the form of the animals the *ANATINIDÆ* offer such a large amount of variation, that it will be better to point out these differences when speaking of the characters of each sub-family. All of them, however, have the mantle margins united, with an opening at the antero-inferior side for the protrusion of a small digitiform foot; the siphons are more or less prolonged, united in their entire length or only at the base, and the united portion of these siphons is almost invariably covered with an extension of the epidermis which covers the shell. There is also a small opening in the mantle below, at the base of the siphons. The gills are thin and in many cases (though not invariably) single. The palpi are usually long and narrow.

The shell is generally thin, consisting of two usually well defined layers, the outer being opaque, calcareous, very often punctated or finely granulated, the inner pearly; the latter is never wanting, and it forms the principal distinction of these shells as compared with those of the *MYIDÆ*. The cartilage is internal, lying either in special processes or in simple grooves of the hinge, which is occasionally strengthened by a few ribs or laminae, but very rarely has any additional teeth. The cartilage is, as a rule, bounded internally by a solid ossicle, variable in form and position; an external ligament is besides often present, but it is generally small and thin; the muscular impressions are, on account of the thickness of the shell, slightly developed, they are large, and the posterior is usually deeper and more rounded than the anterior; the pallial impression is also faint, but the sinus usually deep.

If we summarize the characters of the family, we find that the most important distinctions of the shells are its thin pearly structure and the edentulous hinge. These at least are almost the only characters upon which we can depend in the determination of fossil species. The shells are generally inequilateral, but sometimes the anterior, sometimes the posterior, side is the longer, and the last one usually has a wide gape at the end.

In the pursuit of palæontological researches there is scarcely any other family of Pelecypoda so important as this, being represented throughout the strata from the time of the oldest sedimentary deposits upwards. The species living at the present time may be said to be only the remnants of the group; they are distributed all over the world, but they are nowhere very numerous, and some of them belong to the rarest yet known shells. Their maximum of development appears to have been during the jurassic period; at least there are scarcely any jurassic fossiliferous beds known in various parts of the world, where about one-half (or a proportion very near to it) of all the *MYACEA* does not belong to this family. On this account I have especially endeavoured to give as complete a review of all the known types as was possible for me to do, and as far as I felt justified in giving an opinion about them. Much still remains to be done as regards the comparison of recent and fossil generic forms, for the latter are unfortunately mostly known in the form of casts, both valves being often found closed, and thus generally making an examination of the cartilage and other processes of the hinge almost an impossibility. But even where the shells are known, the greatest difficulty is often felt in exposing the hinge, and consequently the determination had to be principally based upon the external form and the general characters of the shell. We can only expect to get very gradually out of this chaos of so-called generic forms, because whenever an author has an opportunity of studying one species properly he prefers calling it a 'new genus,' rather than identifying it with another which may be the same, but of which the internal characters are unknown; as has been the case in several instances.

The extent which I here give to the family is somewhat great, but it seems impossible to separate the various forms satisfactorily. They include, like the *PHOLADIDÆ* or *MYIDÆ*, one characteristic type of shells, and as regards the form of the animals the variations are quite similar to those which I have repeatedly pointed out in speaking of the other families. To make use, however, of the distinctions indicated by the various forms of the shell, I have accepted here three sub-families, the *PANDORINÆ*, *THRACIINÆ*, and *ANATININÆ*, the types of these subdivisions being *Pandora*, *Thracia*, *Anatina*. Comparing the present family and the *MYIDÆ*, I may mention that the *PANDORINÆ*, with their short siphons and fringed orifices, as also the inequality of the shells, appear to be analogous to the *Corbulæ* and their allied genera, the *THRACIINÆ* by their more elongated siphons (and posteriorly narrowed and produced shell) to the *Neæræ*, and the *ANATININÆ*, by their long united siphons and posterior large gape of the shells, to the *MYINÆ*; thus representing a variation which seems to repeat itself in almost every family of the *MYACEA*. For these reasons I believe it to be more correct to retain closely allied types of shells in one family, than to separate them into several, because if we admitted a family division here, we would have to follow it in the other cases also, which seems for the present hardly advisable. H. and A. Adams have included in the *ANATINIDÆ* several forms, like *Poromya*, *Thetis*, *Neæra*, *Theora*, and *Chamostrea*, which do not appear to belong to this family. The first two must be removed

to the *MYIDÆ*, and when speaking of *Neæra*, I also mentioned the true systematic position of *Theora*; as regards *Chamostrea* I agree with Deshayes, that it is far more probably a variation of the *Chama*-type of shells than that of the *ANATINIDÆ*, as restricted.

Deshayes divides the family into three, *PANDORIDÆ*, *OSTEODESMIDÆ*, and *PHOLADOMIIDÆ*. The first corresponds with our *PANDORINÆ*, but includes also *Myochama* and a few genera into which *Pandora* has been separated. The second name includes the recent genera of the *THRACIINÆ* and *ANATININÆ*. The name *OSTEODESMIDÆ* certainly is not well chosen, for, as I shall subsequently show, the author himself hardly appears to admit the generic distinction of *Osteodesma* from *Lyonsia*. For *Pholadomya* Deshayes proposed a separate family, which seems to me scarcely justified by the character of the shell and animal; the fossil species, like *Goniomya*, *Pleuromya*, *Homomya* and others, show an intimate relation between *Anatina* and *Pholadomya*, between both of which there certainly can be much less distinction pointed out, than between *Thracia* and *Anatina*, both of which the same author places in his *OSTEODESMIDÆ*.

A catalogue of the recent species of the *ANATINIDÆ* has been lately published by Mr. T. A. Conrad, chiefly following the classification adopted in H. and A. Adams' "Genera" (*vide* Am. Jour. of Conch., Vol. IV, pt. 5, Appendix p. 49, 1868). It excludes the *PANDORIDÆ* which are catalogued by Ph. Carpenter in the same number of the Journal (page 69, &c.). The total number of recent species of the whole family may be estimated at about 140.

a. *Sub-family*,—*PANDORINÆ*.

The animals of the *Pandoræ*, so far as they have been examined, offer several relations to those of other typical *ANATINIDÆ*. The siphons are only separated towards their ends provided with fringed orifices; the gills are single, the foot is small, digitiform, and the mantle united nearly all round. The shell structure, generally noticed as one of the prominently distinctive characters, is by no means very different from that of some *Periplomæ*, *Thraciæ*, and *Anatinæ*. In these the uppermore calcareous layer is generally preserved in small granules or points, while in *Pandora* (but much less in *Myodora*) the upper layer, consisting of small prismatic cells, is usually more compact and homogeneous; the external layer is in both cases pearly, and often of considerable thickness in *Pandora* and a few allied genera. The cartilage is internal, usually covered by a small ossicle. In most cases, no external ligament seems to exist; it is rudimentary in a few species only. The genera *Myochama*, *Myodora*, *Pandora* (with *Kennerlia*), *Cœlodon*, and *Clidio-phora* have to be placed in this sub-family.

1. *Myochama*, Stutchbury, 1830. Shell thin, irregular, right valve larger and attached; hinge in each valve, with two diverging teeth like processes, including a triangular cartilage-pit, furnished with a moveable ossicle; a very thin external ligament; pallial sinus short and broad.

The animal of *Myochama* in general resembles that of *Myodora*, and equally so the shell, especially as regards its thin structure and the form of the hinge. Although it lives attached to foreign objects, it is impossible to find anywhere else a better place for it. Some authors (Römer and others) have proposed a special family to include *Chamostrea* and *Myochama*. But when comparing the two shells, their form and the character of the hinge are so totally different that it seems quite unnatural to class them together. Certainly *Myochama* is much more allied to *Myodora* (of which it must be considered as an aberrant form), than it is to *Chamostrea*.

Conrad quotes only four recent species from the Australian seas, and some doubtful forms occur in the upper tertiary beds of Europe. The only shell, described from older formations, which has an external resemblance to the recent *Myochama*, is Lycett's Oolitic *Ptychomya Agassizii* (Proc. Cottesw. Nat. Club, I, p. 69, pl. II, fig. 6). Lycett does not state whether both valves of the shell had been found, but the one which he figures is certainly externally very much like the smaller and free valve of a *Myochama*. The hinge is believed to be edentulous, and if this be really the case the valve under description may also be a lower valve of an *Anomya*. Lycett's statement requires confirmation on this point, before we are able to say anything definite about the characters of that supposed *Ptychomya*.

2. *Myodora*, Gray, 1840. Shell subtrigonal, posteriorly truncated; right valve more or less convex, its hinge with two diverging teeth enclosing the cartilage, left valve flattened with two grooves at the beak; ossicle free, rather large; pallial sinus small and broad.—The species of this genus are almost only known from the Eastern and Australian seas; the unequal form of the valves and the position of the cartilage strongly remind us of *Myochama*.

3. *Pandora*, Brug., 1792. Shell ovate, inequilateral, compressed, posteriorly narrowly produced; right valve smaller and flatter than the left one; hinge with an anterior more or less prolonged rib in each valve; cartilage in a groove posterior to the tooth, more or less adjacent to it; no ossicle present; pallial sinus very small. Carpenter (Proceed. Zool. Soc., 1864, p. 601,) restricts the genus *Pandora* to the species of the type *Pand. inæquivalvis* (*inæqualis*?) Linn., *rostrata*, Lam., *P. pumila*, Penn., *obtusa*, Lamarck.

3a. *Kennerlia*, Carpt., 1864, (Proc. Zool. Soc., Lond., p. 602). Under this name Carpenter separates a few species, which still more resemble *Myodora*, than the true *Pandora*. They all have a thin ossicle, and the typical species have radiating ribs on the right valve. *Pand. (Kenn.) bicarinata*, Carpenter, is the type of the sub-genus.

4. *Cœlodon*, Carp., 1864, (ibid., p. 599). The form of the shell is similar to that of *Pandora*; each valve with two hinge-teeth directed towards the anterior adductor muscle, and in the left one they are connected by a thin lamina; no ossicle or pallial sinus.

5. *Clidiophora*, Carp., 1864, (ibid., p. 596). Similar in form to the last; right valve rather tumid, with three hinge-teeth; the posterior one elongated; left valve

often with two teeth; ossicle present, pallial line simple. All the species at present known are from North-American seas.

Pandorina of Scacchi has been considered as identical with *Lyonsia*. *Pandorella* of Conrad is stated by its author to be a true *Pandora* (see Am. Jour. of Conch., 1867, III, p. 269).

Thus we have in place of the genus *Pandora*, as recorded in the works of H. and A. Adams, Chenu, or Deshayes, three, and probably four, tolerably distinct generic forms.

In fossil species the determination becomes, however, very difficult, and in most cases it only depends upon the external shape of the shell. It is, therefore, only natural that, not knowing the hinge-teeth, the oldest name (*Pandora*) will for some time be the safest to be applied. There are, however, a few fossil species from tertiary beds which, if not identical with recent forms, allow a correct generic determination. *Pand. inæquivalvis* occurs in the miocene beds of Vienna; some others from the English tertiary beds mostly also belong to recent forms. Of the species described by Deshayes in his second edition of the Paris fossils, *Pand. Defrancei*, appears to represent a peculiar (generic or sub-generic) type; *Pandora dilata* is evidently a right valve of a *Clidiophora*, and *P. primæva* is a true *Pandora*. *Clidiophora* also occurs fossil in North American tertiary deposits, but the genus evidently had formerly a larger geographical distribution, as illustrated from its occurrence in the Paris basin.

No cretaceous forms are referable with sufficient certainty to *Pandora* or to its allies, and still less certain are those from jurassic and older deposits. When the valves of fossil species are found closed, particular attention is required not to confound them with the shells of *Yoldia* and other allied genera of the *NUCULIDÆ*.

b. Sub-family,—*THRACIINÆ*.

Shells very thin, with a more or less distinct nacreous layer inside; form tellinoid, being usually compressed, rounded in front, somewhat less high and sub-truncate behind; animal with a small digitiform foot and moderately prolonged siphons, separated the greater part of their length, but united at the base.

6. *Tellinomya*, Hall, 1847, (Palæont. of New York, I, p. 151). Shell without any hinge-teeth or crenulations, beaks entire; form typical, rounded and higher in front, lower and sub-truncate behind.

This is apparently the oldest form as yet known of this group of shells; it has been proposed for a palæozoic species from North-America, but there are in similarly old rocks of other countries also species found which are referable to this genus. The shell very probably had a thin external ligament, but the margin is not bent in as in *Thracia*, nor is there, according to Hall, any other tooth present which may have supported a cartilage.

7. *Asthenothærus*, Carpt., 1864, (Ann. Mag. Nat. Hist., XXII, 311). Shell like *Thracia*, hinge without teeth, cartilage situated under the umbones. The species *Ast. villosior* is a recent shell from Cape St. Lucas; its external generic

Tellinomya, Hall, has nothing whatever to do with this subfamily or family! It has a completely different structure, and belongs to the *NUCULIDÆ*.

character would not differ from *Tellinomya*, but though the description of the species is not very clear, it appears to say that there is a special groove or pit under the umbones for the reception of a spongy cartilage. An external ligament has not been observed. Giebel (Abhandlungen Nat. Ver. für Sachsen und Th., vol. i, 1856-58, p. 105), describes a triassic *Tell. edentula* which may belong to this genus; it has apparently a cartilage-pit below the beaks.

8. *Corimya*, Ag., 1842, (Etud. crit., Mon. des Myes, p. 262). Shell very thin, nacreous, slightly inequivalve, with one or usually two long ribs running from the beak posteriorly; hinge edentulous, margin of the shell behind the beaks very slightly thickened, but not bent inside; posterior muscular impression distinct, elongated near the middle of the posterior margin; pallial line indistinct, beaks entire; a thin ligament externally is very probably present. These characters appear to me to justify the separation of *Corimya* from *Thracia*, and it would seem as if the former were the mesozoic representant of the latter. Agassiz when proposing the new genus was evidently led to it more from the general characters, such as the shell-structure, than from any details relating to the hinge. He merely says that the hinge is probably edentulous, but as the form of the shell does not exhibit any marked difference from *Thracia*, it was united with this genus by Deshayes, Terquem, and others. I cannot vouch for the statement that all the species described by Agassiz under the name of *Corimya* belong to that genus; some of them may possibly be *Thraciæ*. The first species of the genus, *Corimya pinguis*, of which I have compared several tolerably well-preserved specimens, exhibits all the characters which I have pointed out above. The posterior internal ribs recall *Pandora*, but I have not observed any groove for the attachment of the cartilage. A large number of the species known belongs to the jurassic period, but there are a great many well-marked types to be found also in cretaceous beds, as I shall subsequently notice in detail; two species occur in our South Indian deposits.

9. *Axinus*, Sow., 1821, (Min. Conch., vol. iv, p. 11). Shell rather thin, anterior side short, rounded, posterior slightly more compressed, produced, with the area somewhat excavated, and a long cartilage (?) groove along the entire upper margins; no other hinge-teeth are known to exist. Sowerby considers *Ax. angulatus* from the London clay as the type of the genus, which has been by some authors identified with Turton's *Lepton*, but I do not see from the existing materials sufficient reason for this. Sowerby's type species indicates a greater relation to *Thracia* than to any other shell I know, and unless this typical species has been properly examined and its characters better defined, it is useless shifting it to, or identifying it with, another genus. M'Coy in his carboniferous fossils of Ireland, p. 63, refers to *Axinus* a number of species apparently belonging to *Dolabra*, *Anodontopsis*, and similar allied genera which will be noticed subsequently.

10. *Thracia*, Leach, 1824. Shell usually rather inflated, inequivalve, more or less solid or thickened, scarcely nacreous internally, edge behind the beaks bent in and prolonged internally into a small cartilage process; pallial sinus broad and deep.—Fossil species belonging to *Thracia* proper are as yet only known from

tertiary deposits; those from cretaceous beds may with equal probability be referred to the former genus. Of recent species about 25 are upon record.

Several of the species of *Thracia* resemble in their rather solid and opaque shell the *Myæ*, at least more so than any other genus of the *ANATINIDÆ*.

11. *Ixartia*, Leach, 1852, (Syn. Moll. Great Brit. ed. by Gray, p. 272; *Rupicola*, Fl. d. Bl., 1802, not Briss., 1769). This genus generally has a somewhat irregular, sub-oval shell, the hinge with a vertical cartilage process, and the pallial sinus small and obtuse. *Ix. distorta*, Montagu, is the best known species.

11a. Chenu (Man. ii, p. 40) adds *Ligula* of Recluz as a sub-genus of *Thracia*, while H. and A. Adams identify the same with *Periploma*. The shell figured by Chenu as *Lig. declivis* is characterized by a strong oblique cardinal process in each valve supporting the cartilage, certainly very similar to that of *Periploma*, except that it is less twisted. In addition to this it is said to differ from the last-named genus by being equivalve and very thin. The name *Ligula* having been, however, by previous authors differently applied, cannot stand, and even if the few distinctions of the shell could be considered sufficient to justify a separation from *Periploma*, I very much doubt that they will hold good in a comparison with the next shell, unless they be based on the somewhat irregular form of the median portion of the shell of the so-called *L. declivis*.

12. *Calcara*, Recluz, 1868, (Rev. de Zool. No. 2, p. 53). Form typical of the *THRACIINÆ*, nearly equilateral, equivalve, hinge with a spoon-shaped cartilage process in each valve directed anteriorly, pallial sinus deep. This name has been proposed for the fossil *Anatina oblonga* of Philippi (En. Moll. Sic. I, p. 8).

13. *Periploma*, Schuhmacher, 1817, (*Galaxura*, Leach, 1852). Shell ovate, inequivalve, left valve being more ventricose than the right one; beaks fissured internally, often supported by radiating ribs, hinge with a spoon-shaped oblique or horizontal cartilage process in each valve, external ligament thin. *P. inæquivalvis*, Schuhm., is the type of the genus.

13a. The shell named by Couthuoy *Cochlodesma* only differs by being subpellucid and somewhat less inequivalve and inequilateral than other *Periploma*. Some species of the jurassic *Corimya* of Agassiz, like *Cor. tenuistriata*, *C. glabra*, and others, appear to be very closely related to this type of *Periploma*.

14. *Pelopia*, H. Adams, 1868, (Proc. Zool. Soc., p. 16). Shell oval, inequivalve, closed on both ends, surface scabrous; hinge with a long horizontal excavated cartilage process; ligament placed in a deep groove. *Pel. brevifrons* (ibid. pl. iv, fig. 16,) is the type of the genus, which differs from *Periploma* by the want of an internal rib below the cartilage process and by not having the beaks fissured.

15. *Alicia*, Angas, 1867, (Proc. Zool. Soc., p. 908). Shell inequivalve, resembling a small *Thracia*, but the posterior portion is much smaller than the anterior, internally sub-nacreous; beaks entire; hinge composed of a posterior callus in the right valve fitting in a cavity in the left one, and an anterior marginal tooth or ridge; cartilage internal under the umbones, covered by a large triangular ossicle; pallial line deeply sinuated. Two species, *Ali. angustata* and *elegantula*, are described from Port Jackson.

16. *Lyonsia*, Turton, 1822, (*Magdala*, Leach). Shell more or less inequilateral, ovate, somewhat gaping posteriorly and often distorted, nacreous inside; hinge with an oblique and marginal cartilage groove in each valve behind the beaks, cartilage covered in front with a flat oblong ossicle. There are numerous palæozoic and mesozoic fossil species which probably will have to be referred to this genus; from the tertiary period about 12 are known, and 15 recent ones are recorded by Conrad in his catalogue of the *ANATINIDÆ*. Deshayes (Paris foss., 2nd edit., pp. 257-258,) argues at length whether it be desirable to distinguish generically between *Lyonsia* and his *Osteodesma*. He states that there are some species which are nearly equilateral, of regular form, and with very unequal valves; others which are irregular, less inequivalve, and very unequilateral. The former, he suggests, could be called *Lyonsia*, the latter *Osteodesma*. This distinction is, however, by no means constant, and scarcely of sub-generic or sectional importance. Deshayes himself, immediately after this discussion, describes two species, *Ly. Heberti* and *plicata*, representing the two forms under the single generic name *Lyonsia*!

17. *Lyonsiella*, Sars, 1868. I only know this name from the quotation in Ann. Mag. Nat. Hist., 4th Ser., vol. iv, p. 429; it is based upon a northern form, *L. abyssicola*, evidently allied to *Lyonsia*, and found in 450 fathoms; the author promised soon to supply a description in the "Vidensk.-Selskabs Forhandlinger." Perhaps he did so before his lamented death.

18. *Entodesma*, Philippi, 1845, may be distinguished generically, because the form of the shell is almost like that of a *Modiola*, or *Saxicava*, with an internal semicircular cartilage process; the ossicle and pallial impression have not been observed. *E. Chilensis* is the type. The form of the shell appears to indicate a passage to *Mytilimeria*.

c. Sub-family,—*ANATININÆ*.

Most of the shells referred to this sub-family have a very thin nacreous, sometimes nearly membranaceous shell, of an oval or elongated form, generally gaping at the posterior end. By far the larger number of forms are fossil, and of the few recent species known the animals are characterized by long united siphons covered with an extension of the more or less hardened epidermis of the shell.

The classification of the *ANATININÆ* is as yet very unsatisfactorily known. Some forms are very tumid and of a cordate shape, like the recent *Mytilimeria*, or the fossil *Ceromya*, and others are elongated and sometimes considerably compressed, as the typical *Anatina* and the fossil *Corimya*. But when we look, for instance, upon the enormous number of known *Pholadomya*, we meet similar variations in one and the same genus. To avoid, therefore, great confusion I have attempted to associate as much as possible the fossil forms with their nearest allies among recent shells. The fossil genus *Ribeira* is by some palæontologists referred to the *ANATINIDÆ*, but Salter considered it to be more allied to the *Estheria*, and that appears probable.

19. *Mytilimeria*, Conrad, 1837. Shell inflated, sub-oval, equivalve, beaks entire, the anterior one curved in, hinge edentulous, with an internal posterior cartilage groove protected by a small ossicle; two small muscular impressions; pallial sinus broad and very shallow. Only a few recent species are as yet known, and from external shape the fossil ones may very easily be mistaken for *Modiola*, or even for species of *Loripes* and allied genera. The fossil *Edmondia* and *Ceromya* appear to be closely related to the present genus.

20. *Edmondia*, Koninck, 1842, (Anim. foss. Carb. Belg., p. 66, and King's Perm. foss. of England, p. 162, etc., pl. xx, figs. 1-4). Shell equivalve, transversally oval, tumid, slightly gaping in front of the beaks, hinge below the beaks with a raised rib or process, extending posteriorly to near the margin and probably supporting a cartilage; area generally distinct with slightly thickened fulcra for the support of an external ligament. A few palæozoic species of this genus are only known. The form of the shell also very much resembles that of some species of *Loripes*, with a thin, finely striated shell.

21. *Cardiomorpha*, Koninck, 1842, (Foss. Carb. de Belg., p. 101). Shell oval, tumid, hinge edentulous, upper marginal edge behind the beaks somewhat elevated, probably for the support of an external ligament, pallial line simple. This is again a form which, if its characters prove to be correct, can scarcely be distinguished from some *Loripes*, except by its small muscular impressions and thin shell. I suspect Mc'Coy's genus *Leptodomus* (Carb. fossils of Ireland, 1844, p. 66,) is identical with it, at least the characters given (loc. cit.) do not exhibit any essential differences. The thin structure of the shell is particularly alluded to. The shell is, however, generically distinct from what Mc'Coy described in 1855 as *Leptodomus* in his work on the palæozoic rocks and fossils. Again, Sandberger, Koninck, and others have described some species as *Cardiomorpha*, which would be more properly referable to Mc'Coy's *Leptodomus* of 1855, probably the same as Lorient's *Plectomya* (see p. 69).

22. *Ceromya*, Agassiz, 1842, (Etud. Crit., p. 25). Shell tumid, with concentric striæ or ribs, often divaricating at the upper posterior margin; right valve generally somewhat larger than the left, hinge edentulous; a shallow groove runs obliquely from the beaks posteriorly and forms behind them a somewhat raised and thickened margin, near which the cartilage must have been situated internally, though very likely there was also a thin external ligament present; in the right valve there is besides a small thickening with an adjoining indentation below the beak; the muscular impressions are very small, the pallial sinus deep.

The *Ceromya* are principally characterized by their tumid, thin, and concentrically laminated shell, distant beaks, and the oblique furrows which are externally traceable. Chenu in his Manual unites the genus with Koninck's *Cardiomorpha* under the latter name, but in this I have never observed any such arrangement for the attachment of an internal ligament (similar to that of *Lyonsia*,) there is along the raised upper margin no trace of a special furrow, and the beaks are closely approximate to each other. For the jurassic beds, especially for the middle series, or

* Chenu does so on p. 47 of his work, but on p. 111, curiously enough, of the same vol. admits *Cardiomorpha* as a distinct genus!

Dogger, the *Ceromya* are almost characteristic, but some species also occur in cretaceous deposits.

23. *Gresslya*, Agassiz, 1842, (Etud. crit., p. 202). Shell oval, generally moderately compressed, beaks rather anterior, incurved, right valve always larger than the left, the former internally behind the beak with a prominent longitudinal rib, to which a cartilage was probably attached, fixing the upper margin of the left valve to it.

The surface of the shell is concentrically striated, and its structure is more solid than in *Ceromya*. Terquem and others consider *Gresslya* to be identical with the former genus, but even setting aside the marked difference in the form of the shell, there seems to me a great difference in the hinge, which in *Gresslya* is more allied to that of *Edmondia*, but in this we have according to Koninck an internal prominent ridge in both valves, which also are perfectly equal; the generic distinctions appear to be, therefore, well founded.

24. *Allorisma*, King, 1844, (Perm. foss. of England, p. 196). Shell oval, equivalve, inequilateral, very thin, hinge perfectly edentulous; only an external ligament is said to be present, attached to slightly thickened long fulcra; anterior muscular impression near the antero-ventral margin; pallial sinus small, but distinct. This genus must most probably be reserved for a number of palæozoic species, unless some described under the next name are referable to it.

25. *Myacites*, Schloth., 1820. Shell oblong, thin, usually punctated, sub-equivalve, inequilateral, posteriorly slightly gaping; hinge edentulous, indented, posterior margin internally thickened, probably for the support of a cartilage; pallial sinus deep; muscular impressions large. This genus is closely allied to *Allorisma*, but there is no distinct trace of an external ligament; its form also very much recalls *Homomya*, but in this strong nymphæ are present externally, while in *Myacites* we have them internally. (See Giebel in Abhandlungen des Nat. Ver. für Sachsen und Thüringen, vol. i, p. 103, pl. iii, fig. 8). It is not satisfactorily known in palæozoic strata, but it is abundant in the Trias and Jura, and some species appear to be found also in cretaceous strata. Morris and Lycett (Moll. Great Oolite, p. 111,) identify Schlotheim's *Myacites*, (which was first introduced for the typical triassic species) with *Pleuromya*, *Arcomya*, *Homomya*, and several other new genera proposed by Agassiz, but this is evidently an inadmissible generalisation of characters, though it cannot be doubted that the correct generic determination of our palæo- and meso-zoic Pelecypoda of this family will long remain unsettled, and the examination of good materials will certainly suggest many important alterations.

I think it probable that Sowerby's genus *Pachymya* which is based upon a cretaceous species, is merely a slightly different form of *Myacites*; as regards form, at least, both are undistinguishable, except that the former is more inflated posteriorly than anteriorly; no hinge teeth are known to exist. Pictet (Pal. Suisse, iv. ser., p. 159,) places *Pachymya* in the *DONACIDÆ*, for which I cannot see the slightest reason, unless the hinge has been examined which it is not stated to have been.

26. *Homomya*, Agassiz, 1843, (Etud. crit., p. 154). Shell like *Myacites*, thin, concentrically striated, but not punctated; hinge, according to Terquem (Mem. Acad. Metz, 1855, [extr.] Observ. s. Etud. crit., &c., p. 35, pl. 1, figs. 3-5,) edentulous, slightly emarginated below the beaks, and with prominent nymphæ for the attachment of an external ligament. Several conchologists altogether ignore the genus *Homomya*. There is no doubt a great difficulty in distinguishing between the former and the present genus, when the hinges of the specimens are not perfectly well preserved. But this does not entitle us to ignore what we already know; but should rather elicit further information on the subject. When externally comparing *Homomya* and *Panopæa* the distinction between the two becomes almost impossible, because there is scarcely any difference to be traced between the form of one and the other, except in the respective thickness of their shells.

I could mention here a few palæozoic genera, as, for instance, *Sanguinolites*, *Orthonota*, *Sedgwickia*, and others, to which no doubt several species have been referred which very likely belong to the *MYIDÆ*, but the typical species are said to be closely allied to *Solemya* which, in the organisation of the animal, is closely allied to the *CRASSATELLIDÆ* and *ASTARTIDÆ*.

27. *Tyleria*, H. and A. Adams, 1857, (Genera II, p. 368). Shell oblong, equi-valve, very thin, gaping and slightly produced posteriorly. Hinge with an oblique cartilage-pit in each valve, a calcareous lamina extending from the cartilage-pit anteriorly as far as the muscular scar; this ridge is parallel to the margin, with which it is connected by short transverse septa. *T. fragilis* is the only recent species known, and its shell is nearly papyraceous; it has some relation to *Anatina*, and also to some of the forms named by Agassiz *Mactromya*, and others.

28. *Anatina*, Lamarck, 1809. Shell thin, translucent, sub-equivalve, attenuated, and gaping posteriorly, beaks fissured, internally often with radiating ribs, cartilage situated in a spoon-shaped cardinal process in each valve, furnished in front with a transverse ossicle, pallial line with a wide and shallow sinus.

Agassiz' fossil genus *Platymya* (Etud. crit., 1843, p. vii,) must, at least in part, be considered as identical with *Anatina* proper; for *Pl. dilatata*, for instance, does not exhibit any characteristic differences, and many others, (except *rostrata*, Ag., which I shall mention under *Plectomya*,) are based upon such indistinct casts that they are even as species worthless for determination. If the form can be considered of any importance, it may be possible to give *Platymya* a sub-generic value, as some of the species, referred to it by Agassiz, are much more compressed than recent *Anatinæ*.

29. *Cercomya*, Agassiz, 1843, (ibid. p. 143,) appears to be a characteristic sub-genus or genus of *ANATININÆ*; it is largely represented among secondary fossils; it differs from *Anatina* proper by having the posterior end much elongated and narrow, and longitudinally grooved with a somewhat distinct curve in the striae of growth. This indicates that the siphons were not much prolonged beyond the posterior end of the shell, being laterally rather compressed, and perhaps partially separated, near their terminations. Thus in several particulars these shells would indicate a relation to *Lyonsia* and *Pandora*. The recent representant of *Cercomya*

appears to be the small *Anat. gracilis* from Australia, though this does not show the character of the siphonal end so well as the fossil forms do.

30. *Plectomya*, Lorient, 1868, (Monog. Pal. Geol. étage Portlandien de l'Yonne, p. 89 : ? = *Platymya*, Agassiz). Shell ovately elongated, equivalve, beaks sub-central, a strong oblique rib posterior to them; hinge edentulous; ligament external. This genus has been based upon a well known jurassic fossil, the *Tellina rugosa* of Römer. Its general form is that of an *Anatina*, and if there be no trace of an internal cartilage-pit, nor of a fissure dividing the beaks, the genus may be retained. But I rather doubt this; we need only to look upon such species as *Anat. Agassizi*, d'Orb., to find a reason for it. However, even should Lorient's definitions prove to be quite correct, it appears to me that Agassiz' *Platymya* has priority, for judging from external appearance *Platymya rostrata*, Ag. (Etud. crit., pl. 10, figs. 11-12,) exhibits all the above noted characters of a *Plectomya*.

31. *Cyathodonta*, Conrad, 1849, (Proc. Acad., &c., Phil., vol. iv, p. 155). Shell like *Anatina* in form; "hinge with a broad, not very projecting fosset, which is carinated near the margin; muscular impressions rounded, indistinct; pallial impression with a large rounded sinus." No mention is made of any kind of the fissure at the beaks. H. and A. Adams consider the genus identical with *Anatina*, but Conrad in his last catalogue of the family keeps it distinct, referring to it four different species.

32. *Plicomya*, Stoliczka, 1870, (*Leptomya*,* Conrad, 1867, Am. Journ. Conch., III, p. 15). Shell oblong, perlaceous, gaping anteriorly; hinge with a spoon-shaped cartilage process, joining an oblique callosity, which extends to the cardinal margin; an obsolete rib and fissure run obliquely from the anterior side of the beak. The genus is evidently closely allied to *Anatina*, from which it chiefly differs by the rib and fissure anterior to the beak; it is based upon a cretaceous species from N. America. Conrad suggests that d'Orbigny's *Peripl. Robinaldina* and two others probably also belong to his *Leptomya*, but I think that they are more probably species of *Corimya*.

33. *Anatimya*, Conrad, 1860, (Jour. Acad. Nat. Sc., Phil., 2nd Ser., iv, p. 276). Shell oblong like an *Anatina*, anterior side with concentric sulci, posterior with radiating ribs. This form appears to be peculiar to cretaceous deposits. There are as yet only a few American species known.

34. *Anthracomya*, Salter, 1861, (Mem. Geol. Surv. of Great Britain, "Iron Ores," pt. iii, p. 229). Shell thin, nearly equivalve, left valve a little smaller than the right one, dilated posteriorly, but closed anteriorly, rounded; posterior hinge line with a narrow anterior ridge (? like in *Gresslya*); ligament external. This is based upon *Anth. Adamsi*, Salt., and a few other carboniferous fossils. The characters somewhat recall *Conchocele*, Gabb, which, however, may be better placed in the *LUCINIDÆ*. Salter states that *Anthracomya* was either marine or brackish, and that it occurs with *Anthracosia* (*UNIONIDÆ*) in the same beds.

* Non idem A. Adams, 1864 (*SCROBICULARIIDÆ*).

35. *Chænomya*, Meek., 1865, (Pal. of Upp. Mo., p. 42, and Proc. Phil. Acad., 1865, p. 250). Shell much like *Anthracomya*, of thin structure, more or less compressed, posteriorly gaping; hinge with an internal ligament.

36. *Pleuromya*, Agassiz, 1842, (Etud. crit., p. 231). Shell oblong, equi-valve, inequilateral, thin, concentrically striated or ribbed, with an oblique process below the beaks of each valve, probably supporting an internal cartilage; nymphæ prominent for the attachment of an external ligament; sinus very deep and usually angular (*vide* Terquem, Observat., &c., p. 54). Terquem has sufficiently proved that Agassiz' *Pleuromya* is a good genus, and must be kept separate from *Homomya*, *Myacites*, and *Panopæa*, which it externally greatly resembles. The species are both cretaceous and jurassic, but only in a few instances has the internal structure of the shell been as yet examined. *Anoplomya*, Krauss, 1843, (Nov. Act. Acad. Cæs. Leop-Carol, 1855, vol. xiv, pt. II, p. 445,) evidently is a synonym of *Pleuromya*; it is based upon specimens in excellent preservation, and Krauss gave a very good description of the genus. At the time of the publication of his name the last author could scarcely have suspected the identity of his shell with *Pleuromya*, so insufficient were the generic characters given by Agassiz; but since Terquem published his observations on the "Etudes critiques," the matter has become quite clear. Agassiz also described a number of species under the name *Myopsis*, but Pictet and Campiche state that all those occurring in the cretaceous beds at St. Croix belong to *Panopæa* and not to *Pleuromya* or *Myopsis*. Terquem has shown that in some instances (referring to the jurassic species) both genera are identical.

37. *Gonyomya*, Agassiz, 1842, (Etud. crit., p. 1). Shell oblong, rather compressed, thin, surface marked about the middle of the flanks with angularly bent striæ or ribs; hinge without teeth; a slight incision below the beaks and slightly thickened nymphæ beyond the same for the attachment of a ligament are present. The genus is only known from jurassic and cretaceous deposits.

38. *Pholadomya*, Sow., 1823. Shell oblong, thin, pearly inside, in front occasionally very much inflated and truncated, posteriorly always gaping, surface marked with ribs radiating from the beaks; hinge with a small transversally elongated tooth in each valve, adjoining to which there is a small pit; ligament short, external.

This genus includes a large number of species, variable in form, but always possessing the characteristic radiating ribs. It is very largely represented in mesozoic rocks (most numerous in the jurassics), but decreases considerably in the tertiary strata, and only one species was found living in the West Indies. A grouping of the fossil *Pholadomyæ*, such as that proposed by Agassiz, is of great convenience in the determination of the species, and ought to be carried out thoroughly, but very good materials are required for such work, because the form of many species is not the natural one, but is often produced by accidental pressure of the rocks in which they are imbedded. When quoting the cretaceous species of *Pholadomya*, I shall point out those species which belong to other related genera, such as *Goniomya*, *Homomya*, and others.

In connection with *Pholadomya* I have to notice *Liopistha*, Meek (Check List North-Am. Inv. fossils, Cret., Smith. Misc. Coll., No. 177, p. 32). It is based upon *Card. elegantulum*, Römer, from Texas, one of the species of the same type as *Phol. caudata*, Goldf., but according to Conrad these shells are said to possess the hinge of *Papyridea* (of the *CARDIIDÆ*). *Ph. caudata*, I satisfied myself, has the hinge of a *Pholadomya*, but of the other species I have not examined the hinges.

39. *Cymella*, Meek, 1864, (Smith. Misc. Coll., No. 177, p. 34). This has been proposed as a sub-genus for the cretaceous *Ph. undata*, Meek and Hayden, and characterized as follows:—Shell small, sub-equilateral, and ovate, with numerous well defined concentric undulations, crossed on the middle of the valves by a few impressed lines, not marked in the depression between the ridges. A large number of those species of *Pholadomya*, which I shall quote as probably belonging to *Poromya*, answer to this characteristic pretty fairly.

40. *Machomya*, Loriol, 1868, (Bull. Soc. des sc. de l'Yonne, Monog. étage Portlandien, p. 81, pl. vi, figs. 8-9). Shell oblong, sub-compressed, equivalve, strongly inequilateral, rather solid and with punctated surface; a strong radiating rib issues from the umbones and runs towards the anterior margin; ligament external, solid. The hinge is not known, but the form of the shell with its strong external ligament appears to form a passage to the *Panopææ*. One jurassic species (*M. Dunkeri*, d'Orb.) has as yet been referred to the genus, but many more no doubt exist; only the principal character of the genus is such that without the examination of the internal structure of the shell the generic determination cannot easily be depended upon.

When the hinge of *Machomya* has been made fully known, it will be necessary to compare it with that of *Vanganella* (of the *LUTRARIINÆ*), which also has an internal anterior rib extending from the umbones towards the anterior margin. Equally necessary will be a comparison with *Mactromya*, which Pictet and Campiche have re-established and placed in the *TELLINIDÆ*. I have little doubt that *Mactromya* in part is identical with *Machomya*; it has a perfectly similar anterior rib and an external ligament, but as the shell of the latter has the sculpture of that of other *Anatinæ*, and as I have no opportunity to examine the type species, I must leave the question to be settled by those who have better means of obtaining access to the originals.

LIST OF CRETACEOUS SPECIES.

The following genera and species have been noticed as occurring in cretaceous deposits (see Pictet's Pal. Suisse, iv. ser., 3^{me} partie). Pictet and Campiche admit, of all the *ANATINIDÆ*, only three genera in cretaceous rocks, *Anatina*, *Thracia*, and *Pholadomya*.

Of *PANDORINÆ* no cretaceous species are as yet known. D'Orbigny transfers Deshayes' *Pandora æquivalvis* to *Crassatella*, but the species seems to be much more allied to *Pharella*, or to *Psammobia*, than to that genus.

THRACIINÆ.

Pictet and Campiche (l. cit., p. 118,) have referred all the cretaceous species belonging to this sub-family to *Thracia*, evidently because they consider this course to be a convenient one. They do not acknowledge any forms belonging to *Periploma* or *Lyonsia*, but they point

to the distinction of certain species which Agassiz described under the name of *Corimya*; the conclusions to which they arrive are, however, not in favor of a generic distinction of those forms from *Thracia*. I shall refer to these distinctions when quoting the respective species. I may only remark that, so far as I had opportunity of examining some of the mesozoic species, described as *Thracia*, they did not appear to have the hinge margin behind the beaks inflected, and the shell is also in most cases much thinner than we usually see it in recent *Thracia*; I do not think there are among them many species which will finally be proved to belong to the last named genus.

1-4.—*Thracia vulvaria*, Ag., *Th. Nicoletti*, Ag., *Th. Robinaldina*, d'Orb., *Th. neocomiensis*, d'Orb., are all species of *Corimya*.

5.—*Th. sub-depressa*, d'Orb., is an altogether doubtful species, and ought to be struck out of the list of cretaceous fossils.

6.—*Th. subangulata*, Desh., appears to be a *Corimya*, though it is difficult to separate it from *Anatina*, at least from the form which Agassiz called *Platymya* (in parte), and Lioriol lately *Plectomya*.

7.—*Th. taurica*, Ag., has more the form of some recent *Thracia*, than that of a *Corimya*; no posterior ribs appear to exist, and the species may, therefore, be a true *Thracia*.

8.—*Th. Phillipsii*, Röm., is a true *Corimya*.

9.—*Th. recurva*, d'Orb., (*Mya depressa*, Phill., and *Th. Phillipsi*, Morr.) is probably the same species as the former.

10.—*Th. subrotundata*, Pict. and Camp. (= *Lyonsia subrotundata* = *Panopaea rotundata*, Sowerby), must stand as *Corimya rotundata*, Sow., sp., should it be proved to be different from *C. recurva*, which is very improbable, even should the last be distinct from *C. Phillipsii*.

11.—*Th. Couloni*, Pict. and Ren., may be a *Corimya*, or a species of *Plectomya* (= ? *Platymya*), a sub-genus of *Anatina*. Pictet and Campiche consider it a doubtful species.

12.—*Th. Ricordeana*, d'Orb., is not known by any sufficient characteristic or a figure; the reference made (Prod. II, p. 117,) to *L. Rouyana*, (under which name a species of *Lyonsia* was never published by d'Orbigny or any other author), may possibly mean *Anatina Royana*, and in such case it would indicate that the species in question may belong to the same genus as the former.

13.—*Th. simplex*, (*Periploma id.*, d'Orb.) is a *Corimya*.

14.—*Th. Sanctæ-crucis*, Pict. and Camp., may be a true *Thracia*, with the margins behind the beaks bent internally, as they are not visible in fig. 8b, l. cit., pl. 108.

15-17.—*Th. rotundata*, *alpina* and *Sabaudiana*, Pict. and Roux, may all be species of *Thracia*, but if the first should prove to be a *Corimya* its name must be changed.

18-19.—*Th. carinifera* and *elegans*, d'Orb., may both be *Thracia*; they are slightly inequivalve.

20.—*Th. Koechlina*, d'Orb., is an undetermined species.

21.—*Th. gibbosa*, d'Orb., has the external form of an *Ixartia* (= *Rupicola*).

22.—*Th. Sapho*, *Periploma id.*, d'Orb., is merely known by name.

23-25.—*Th. inornata*, d'Orb., *Th. Condamyi* and *Baylei*, Coq. The first is known almost only by name, the others are accompanied by characteristic descriptions which may be found sufficient for the identification of the species. They are both strongly inequivalve, and may with equal probability belong to either *Periploma* or *Thracia*.

26.—*Th. elongata*, Röm., may be either a *Thracia* or any of the closely allied genera.

27.—*Th. Germari*, Gieb. apud Gein., is very likely a *Corimya*.

28.—*Tellina Reichii*, Römer, (Nord. Kreidegeb., p. ix, fig. 26), which is similar to *L. recurva*, d'Orb., evidently is also a *Corimya*. D'Orbigny considered it to be a *Thracia*, but Pictet and Campiche suggest that it may rather be a *Psammobia*.

The *Lucina lenticularis* apud Reuss (Böhm. Kreid.—Verst., pt. ii, pl. 37, fig. 17,) seems to be more allied to a *Thracia* than to the species described by Goldfuss under this name.

28 a.—*T. Picteti*, Favre, (Descript. d. M. foss. de Lemberg, Genève, 1869, p. 106, pl. 12, fig. 2,) is probably a *Corimya*.

29.—*Th. æqualis*, Eichwald (Leth. Ross., livr. xi, 1867, p. 736), said to be a neocomien species, appears to be a true *Thracia*.

30.—*Th. Frearseana*, D'Orb., (ibid. p. 738) is a *Corimya*; it is stated to occur in the neocomien beds at Choroschówo with *Th. elongata* of Römer. Eichwald (loc. cit., p. 728, etc.,) also quotes the following from beds which he considers as neocomien, but which are more likely jurassic: *Lyonsia meniscus*, Eich., (doubtfully neocomien), and *Lyons. Alduini*, Fisch.; both evidently are *Gresslya*, and most likely jurassic.

31-32.—*Periploma Verneuilli* and *P. Lorieri* of Coquand (Monog. étage Aptien de l'Espagne, 1865, p. 99, &c.) are both *Corimya*.

33.—*Lyonsia Peinii*, Coq., is the only species known from Africa; it appears to be a *Thracia*.

34-39.—*Thracia gracilis* (?), *occidentalis*, ? *Prouti*, *subtortuosa* (?) *subtruncata*, and *Periploma applicata*, are quoted from North America by Meek in his Check list, Smith. Misc. Coll., No. 177, 1864.

40.—*Anat. Columbiana*, d'Orb., (Paléont. Voy. Am. mérid., pl. 18, figs. 16-17,) is very likely an aberrant form of *Corimya* or *Anatina*; it has, besides one posterior, two other ribs, one across the middle and one anteriorly to the beaks, but all the ribs have the same oblique direction.

41.—*Th. corbulopsis*, Gabb, is from Chili.

42-43.—*Corimya Oldhamiana* and *pertusa* are the only two species representing this sub-family, in the South Indian cretaceous deposits.

ANATININÆ.

44.—*Ceromya neocomiensis*, Ag., (Etud. cret. Myæ, p. 36, pl. viii f, figs. 1-10), is a typical *Ceromya*, and Agassiz (ibid. p. 35, &c.) also described a *Ceromya crassicornis*; the figure given loc. cit. shows that the shell was like a *Ceromya*, but it does not give any positive proof of it. If, however, Pictet and Roux are correct in identifying their species (described Moll. Grès. vert., &c., pl. 31, fig. 3, and Pal. Suisse, iv. Ser., *Cyprina id.*) with the above, it could scarcely be looked upon as a *Ceromya*, because the shell of the specimen figured by the latter authors evidently was a thick one with deep muscular impressions which could not be produced by a thin shell like that of *Ceromya*.

It seems to me also probable that d'Orbigny's two species, *Isocardia Carantonensis* and *cryptoceras* are both *Ceromya*, although d'Orbigny figures in the former some impressions of teeth, but these may as well be derived from the undulated margin of a *Ceromya*. I could quote many other species, such as *Isoc. Washita*, Marcou, *Isoc. gaultina*, described by Pictet and Campiche, and others, but it is impossible to state anything positive about them. Even, in possession of some specimens resembling the various casts figured, one is not certain whether they really are the species they are stated to be, or something quite different.

Ceromya recens, Coq., (Étage Aptien de l'Espagne, p. 97, &c.), appears to me to be more likely a *Poromya* than a *Ceromya*, as one of the best characters of the last genus, the incurved beaks, are wanting.

45.—One species of a true *Ceromya* which was described by Forbes as *Isocardia subsinuata* occurs in the South Indian cretaceous deposits.

46-47.—*Anatina Agassizii* and *dilatata* both have an oblique internal rib posterior to the beaks, like in *Plectomya*, but do not apparently differ essentially from *Anatina*.

48.—*Anat. carinata* (*Solen id.*, Matheron,) is too imperfect to admit a correct generic determination; if Matheron's figure represent a perfect specimen, the form of the shell would be that of a *Ceratisolen*.

49.—*A. subsinuosa*, d'Orb., is a true *Anatina*.

50.—*A. solenoides* (*Pholad. id.*, Desh.). The figure does not give any proof that this is an *Anatina*; it may as well be a *Pleuromya* or *Panopæa*.

51-58.—*A. Astieriana*, *Carteroni*, *Marullensis*, *Cornueliana* of d'Orbigny, *A. inflata*, Ag., sp., *A. valangiensis*, P. and Camp., *A. Orbignyana*, Lorient, *A. brevissima*, P. and C., are all species of *Anatina*; the last may belong to the sub-genus *Plectomya*, should this really prove to be distinct from *Anatina*.

59-60.—*A. Robinaldina*, d'Orb., *A. gurgitis*, P. and Camp., belong to the sub-genus *Cercomya*; the first was also found by Coquand in the Aptien of Spain.

61.—*A. Rhodani*, P. and R. (closely allied to *Marullensis*), and *A. Heberti*, P. and Ren., are *Anatinae*; the last species is a peculiar form, like a *Gresslya*.

62-64.—*A. thraciformis*, Buv., *A. Royana*, d'Orb., *A. Nadclasi* are *Anatinae*.

65-68.—*A. lanceolata*, Gein., *harpa*,* Kner, and *elongata*, Reuss, belong to the sub-genus *Cercomya*, but they are based upon such bad or imperfect specimens that a good specific determination is quite impossible.

69.—*A. producta*, Zittel, is a *Cercomya* (vide Denksch. Akad., Wien, xxiv, pl. ii, p. 114, &c.). The same author also described *A. Royana*, d'Orb., from the Gosau deposits of the Austrian Alps.

70.—*A. Cenomanensis*, Guéranger (Album paléont. de la Sarthe, pl. xv, fig. 7), is a *Cercomya*.

71.—*Anatina solenoides*, d'Orb., (Süd.-Bayerns Leth. Geogn. by Schafhäutl, 1863, p. 175, pl. xlv, fig. 3). If this at all belongs to the *ANATINIDÆ*, of which there is no distinct proof, it would belong to the group of the compressed forms which Agassiz called *Platymya*. The shell is said to be a cretaceous one, but it certainly has very little or nothing in common with the *Pholadomya solenoides* of Deshayes, which d'Orbigny places in *Anatina*.

72.—*A. rugosa*, Bell., non Lam. (Mem. Soc. Geol., France, ii. ser., vol. iv, p. 233, pl. xvi, fig. 13). A nummulitic species from the neighbourhood of Nice is quoted by Eichwald (Leth. Ross., livr. xi, 1867, p. 727,) from some cretaceous strata of Russia. The identification may well be questioned, judging from Eichwald's description, who states that the posterior side is longer than the anterior, while in Bellardi's species the contrary is the case. Bellardi's species itself is by no means certain to be an *Anatina*; it is more probably a *Thracia*, but should it prove to be either one or the other, its specific name has to be changed.

73.—*A. (Cercomya) acuminata*, Eichwald, Leth. Ross., livr. xi, p. 728.

74.—*A. Jettei*, Coq., is an *Anatina*, and rather like *A. Royana*.

75-76.—Meek quotes in No. 177 of the Smith. Misc. Coll. (p. 14) *A. elliptica*, Gabb, and *sulcatina*, Shumard.—*Anat. columbiana* has been already mentioned (p. 73).

77-80.—*A. Tryoniana*, *A. inaequilateralis*, and *A. lata* are described by Gabb in the Palæont. of California, (vol. i, p. 150, &c.). The first and second have the usual compressed form of cretaceous *Anatinae*; the last looks more like a caste of an *Acropagia* than that of an *Anatina*; *Anat. quadrata*, Gabb, (ibid. vol. ii, p. 177,) may also represent a *Tellinomya* or a *Corimya*.

81.—*Anat. (Cercomya) arcuata*, Forbes, is the only species of *ANATININÆ* from the South Indian cretaceous deposits; the species is quoted by Bosquet also as occurring in the upper cretaceous deposits of Limbourg.

82-84.—*Anatimya anteradiata*, *postsulcata*, and *papyra* of Conrad, see No. 177 of Smiths. Misc. Coll., p. 14.

Species of, and allied to, *Pholadomya* (see Mat. p. l. Pal. Suisse, iv ser., 3^{me} pt., p. 90). Most of the cretaceous species of *Pholadomya* belong to the section *MULTICOSTATÆ*, to which also the recent species is referable, and to the *OVULATÆ* or *PAUCICOSTATÆ*, only a few to the *CARDISSOIDES* and *TRIANGULARES*.

85-90.—*Ph. gigantea*, Sow., *elongata*, Münst., *Ph. semicostata*, Ag., *Ph. Galloprovincialis*, Math., *Ph. Figeriana*, Cotteau, *Ph. alternans*, Römer, (all are *MULTICOSTATÆ*);—*Ph. minuta*, Lorient, (*CARDISS.*);—*Ph. Guilleroni*, P. and C., (*OVUL.*);—*Ph. scaphoides*, Ag., sp. (may as well be a

* Lately redescribed by Favre, Descript. d. Moll. foss. de Lemberg, Genève, 1869, p. 107.

Homomya);—*Ph. sanctæ-crucis*, P. and Camp., (OVUL. ?);—*Ph. valangiensis*, P. and C.; *Ph. icauensis*, and *Ph. Cristoliana*, Math., probably belong to *Poromya*;—*Ph. Pareti*, Math., *Ph. sinuosa*, Math., and *Ph. obliqua*, (*Panopæa* apud d'Orb.), have very much the appearance of *Pleuromya*, and the last two species are likely to be the same.

The cretaceous species described by Agassiz as *Myopsis* (= *Pleuromya*) will be noticed under *Panopæa*. I may only remark that these appear to be true cretaceous *Pleuromya*, distinct from *Homomya* or *Panopæa*.

91-102.—*Goniomya caudata*, Ag., (*Ph. Agassizii*, d'Orb.), *Gon. Villersensis*, P. and C., *Gon. Rouyana*, d'Orb., are noted as *Pholadomya* by Pictet and Campiche.

103-106.—*Ph. Martini*, Forb., (MULTIC.);—*Ph. pedernalis*, Röm., (OVUL.);—*Ph. Cornueliana*, d'Orb., (very much like *Ph. æquivalvis*, Goldf., sp., MULTIC.);—*Goniomya Archiaci*, Pict. and Renev., (*Ph. thracioides*, Pictet and Camp.).

107-111.—*Ph. Genevensis*, Pict. and Roux., (TRIANG.);—*Ph. Fabrina*, d'Orb., and *Ph. Tribolleti*, Pict. and Camp. (MULTIC.);—*Goniomya (Pholad.) Rauliniana*, d'Orb.; *Ph. Dutempleana*, d'Orb., (CARDISS.?).

112-116.—*Ph. Ligeriensis*, d'Orb., (probably a *Poromya*);—*Ph. cordiformis*, Desh., (not *Ph. cardiformis*, as stated by Pictet and Campiche), is likely a *Pleuromya*;—*Ph. subdinensis*, d'Orb., (MULTIC.);—*Goniom. Mailleana (Pholad. id.)*, d'Orb.; *Ph. (Pachymya =? Myacites) gigas*, Sow.

117-128.—*Ph. Archiaciana*, d'Orb., (MULTIC.);—*Goniomya (Pholad.) Noueliana*, d'Orb.; *Ph. Esmarki*, Nills., sp., (Zeitsch. Deutsch. Geol. Gesell., xv, p. 145), CARDISS.;—*Ph. nodulifera*, Münster,* (= *Ph. albina*, Röm.), *Phol. elliptica*, Münster. (= ? *Ph. Royana*, d'Orb., (MULTIC.);—*Ph. decussata*, Mant., sp. (see Zeitsch. Deutsch. Geol. Gesellsch., 1863, xv, p. 143), *Ph. Marrotiana*, d'Orb., *Ph. Moulinsii*, d'Orb., (CARDISS.);—*Ph. rostrata*,† Math., (MULTIC.);—*Ph. umbonata*, Röm., and *Ph. Kasimiri*, (Kazimiri), Pusch., (CARDISS.);—*Ph. æquivalvis*, Goldf., (MULTIC., see p. 79);—*Goniomya designata*, Münster. = *G. Geinitzii*, d'Orb.

Schafhäutl names a *Phol. lignitica*, occurring in lignitic sandstone near Miesbach, which is probably tertiary, though he does not say so. The same author quotes *Ph. Esmarki* from the Gosau beds on the Kressenberg, (Süd-Bayern's Leth. Geog., p. 176). Gümbel (Bayer. Alpen.) quotes the same from Siegsdorf.

129-134.—*Ph. hispanica*, *P. recurrens*, and *Ph. Collombi* (MULTIC.);—*Ph. sphæroidalis*; *Panopæa* (on the plates *Pholadomya fallax* and *aptiensis*, (both of which are probably *Poromya*, and the last may also be a *Pleuromya*), see Coquand, Étage Aptien de l'Espagne, 1865, p. 92, &c. The same author quotes *Ph. Cornueliana*, *Ph. pedernalis*, and *Ph. gigantea*, Sow., which last name has preference before that of Münster's *Ph. elongata*.

135-137.—*Ph. obliquissima*, *cordata*, and *Stewarti* are described from Ireland by Tate (Quar. Jour. Geol. Soc., Lond., xxi, 1865, p. 40, &c.).

138.—*Ph. granulosa*, Zittel (Denksch. Akad., Wien, xxiv, pt. ii, p. 116) (MULTIC.).

139-152.—Eichwald (Leth. Ross., livr. xi, 1867, p. 748, &c.), quotes the following species from cretaceous rocks of Russia, but his Neocomien is in part probably a jurassic deposit: *Ph. scala* (= *Ph. decorata* apud Rouillier), *Ph. inæqualis* (= *Ph. literata*, apud Trautschold), *Ph. inæquicosta*, are MULTIC.;—*Ph. Uralensis*, d'Orb., resembles an inflated *Thracia*;—*Ph. monticola*, (CARDISS.);—

* Pictet and Campiche consider *Ph. nodifera* and *elliptica* of Münster as identical, which is, I think, a mistake. With the first Römer's *albina*, with the second d'Orbigny's *Royana*, have probably to be identified; the form of both agree, but the direction of the ribs is somewhat different; I do not think that the granulations on the ribs are of any particular importance.

† Zittel (Denksch. Akad., Wien, 1865, xxiv, pt. ii, p. 115,) identifies with this species one from the Gosau, and besides describes a variety which he calls *Ph. rostrata*, var. *Royana*, d'Orb. If that peculiar form is to be considered as a special variety, the name *Ph. rost. var. prægnans*, Zittel, ought to be applied to it, for its form is by no means that of d'Orbigny's *Royana*, (see also Eichwald in Leth. Ross., livr. xi, p. 762).

Ph. interrupta, *Ph. consobrina*, *Ph. dilatata*, Keyserling, *Ph. Borrissäkii*, *Ph. navicularis*, (CARDISS.);—*Ph. costifera*, *Ph. taurica*, the last two species have an internal ridge running obliquely from the beaks towards the periphery, like in most of the *PHOLADIDÆ*.

153-154.—*Ph. Darrassi* (not *Barrassi* as entered by Pictet and Campiche) and *Molli* of Coquand are two species which rather belong to *Poromya* or *Pleuromya* than to *Pholadomya*. A few species may be added from Africa, if any of those now considered jurassic deposits, but pronounced by Krauss to be cretaceous, should turn out to be of the latter age.

155-164.—Meek (Smith. Misc. Coll., No. 177,) quotes from North America *Homomya alta*, (may also be a *Poromya*), *Ph. elegantula*, *occidentalis*, *papyracea*, *subventricosa*, *subelongata*, *tenua*, (—is?), *texana*, *tippiana*, and *Ph. (Cymella) undata*; besides *Ph. pedernalis* and *umbonata*, Röm., which have already been mentioned.

165-166.—*Goniomya americana* and *borealis*, (*ibid.*).

167-172.—Gabb (Pal. Calif. i, p. 152, &c.) describes *Ph. Brewerii* (MULTIC.),—*Ph. nasuta*, (CARDISS.),—*Hom. concentrica*, Gabb, *Arcomya undulata*, *Pleuromya papyracea*, and *Ph. Oregonensis*, Gabb, (Pal. Calif. ii, p. 235-236).

173.—*Ph. sancti-sabæ*, Römer, (Texas, *Cardium id.*, p. 48).

174.—*Pachymya Austinensis*, Shumard, Trans. Acad., St. Louis, 1860, p. 604.

175-176.—*Ph. syriaca* and *decisa*, Con. (Off. Report in Lynch's Exped. to Palestine; see also Fraas in Würtbg. Nat. Jahreshefte, xxiii, p. 238).

177-180.—In the South Indian cretaceous deposits four species occur. *Ph. caudata* is identical with the European species; another was named by Forbes *connectans*; the two others are new, *Ph. radiatula* and *pedisulcata*; the first of these belongs to the type of *Ph. rostrata*; the second is a peculiar elongated form with the front sides sulcated, and gaping.

Thus, we observe from this very brief review that the cretaceous beds possess nearly as great a variety of generic types of the *ANATINIDÆ* as do the jurassics. The genera which are sufficiently well known are *Thracia*, *Corimya*, and very probably *Periploma* and *Asthenothærus*; *Anatina* (with *Cercomya*, *Anatimya*, *Plectomya*, and perhaps *Platymya*); *Ceromya*, *Goniomya*, *Pholadomya*, *Myacites*, and very probably *Homomya* and *Pleuromya*. Several species described as *Pholadomya*, but most likely belonging to *Poromya*, still have to be separated from the great number of true *Pholadomyæ*.

CORIMYA, Agassiz, 1842 (see p. 63).

✓ 1. CORIMYA OLDHAMIANA, Stoliczka, Pl. II, Figs. 14-15.

Cor. testa oblonga, compressiuscula, tenui, postice anguste hianti, inæquilaterali, parte postica breviori quam antica ad marginem superiorem multo compressa; utrinque lente rotundata; umbonibus prominulis, postice versus curvatis, in parte posteriori distincte fissuratis: fissura obliqua, ejusdem marginibus inversis tumescentibus, postice sed juxta hanc fissuram costa crassiuscula dimidio altitudinis testæ equante sita; superficie concentrice striata ac lineis interruptis radiantibus per-tenuibus induta; valva sinistra paulo majori quam dextra.

Height of shell	:	its length	...	...	...	...	0.51
Thickness	„	:	„	...	...	...	0.26

The external calcareous layer of the shell which is very finely concentrically striated is thicker than the inner nacreous layer, on which, however, some short

radiating lines are generally much more easily traceable than on the former. The shell is greatly compressed, the anterior portion being longer than the posterior one, the latter considerably attenuated towards the upper edge; both ends are roundish, the posterior somewhat obliquely truncated and slightly gaping. In the middle of the lower edge there is in some specimens a slight indentation observable. The beaks are curved backwards, not very prominent, and in all the specimens which I have examined obliquely fissured on the posterior side; this fissure has the margins inflected internally, which sometimes appear to unite again; behind this fissure follows a very long oblique strong rib, which runs along the front edge of the posterior muscular impression and as far below as its base. The hinge is edentulous, but the hinge-margins behind the beaks are internally for some length considerably thickened, and there also are long fulcra externally traceable in each valve. The left valve is usually somewhat larger, and the right one somewhat more tumid, but these characters do not appear constant.

This is a very characteristic species. In size and form it does not resemble any known from cretaceous rocks, but it is rather closely allied to some jurassic species, such as *C. lata* or *pinguis*. I have great pleasure in associating with this interesting species the name of our esteemed Superintendent of the Survey.

Locality.—In calcareous sandstones north of Alundanapooram and south-west of Kunanore; the species is not uncommon, and the valves are always found closed, indicating that the shells were living at some depth in mud in which they were buried, and not on a gravelly ground and a shallow beach, where shells are sometimes moved about for years and worn off before they become finally imbedded.

Formation.—Trichinopoly group.

✓ 2. CORIMYA PERTUSA, *Stoliczka*, Pl. II, Figs. 12-13, and Pl. XVI, Fig. 18.

C. testa elongata, compressa, pertenui, intus margaritacea, in superficie concentric striata, inæquilaterali, parte anteriori longiori quam posteriori; umbonibus adpressis, paululum antice versus incurvis; cardine edentulo, intus duabus costis divergentibus instructo.

Height of shell	:	its length	...	...	...	...	0.50
Thickness	„	„	...	...	...	...	0.19

Shell much elongated and compressed, very thin, concentrically finely striated, inequilateral, the anterior part about one-fourth longer than the posterior; the upper and lower margins are sub-parallel, the upper being slightly inclined from the beaks, which are very little prominent, close together, and apparently slightly incurved towards the longer end. The internal ribs diverging from the edentulous hinge are very little raised, the posterior is somewhat longer, situated close to the edge of the muscular impression; the margins of the shell are slightly thickened in front and behind the beaks, posteriorly the short fulcra are distinctly traceable.

Locality.—In a calcareous, bluish or brownish sandstone near Pondicherry.

Formation.—Valudayur group.

CEROMYA, Agassiz, 1842 (see p. 66).

✓ 1. CEROMYA SUBSINUATA, Forbes, sp., Pl. IV, Fig. 4.

1846. *Isocardia subsinuata*, Forbes, Trans., Geol. Soc., Lond., vii, p. 146, pl. 17, fig. 12.

C. testa inflata, altiori quam longa; tenui, concentrice sulcato-striata, rotundata, æquivalvi; umbonibus productis, attenuatis, distantibus, antice versus valde incurvis, sulca duplici haud profunda ab umbonibus usque ad marginem postero-inferiorem decurrente instructa; lunula profunda, cordiformi, marginata; cardine edentulo, duobus sulcis obliquis brevibus inter umbones sitis predito.

Height of shell	:	its length	...	...	...	...	1.16
Thickness	„	:	„	...	...	...	1.04

The external form of this species is perfectly similar to that of a *Glossus* (*Isocardia*), but it is readily distinguished from this genus by its thin shell and edentulous hinge, the hinge-margin being simply a little indented at the termination of two short grooves which run obliquely from the beaks posteriorly. Besides these there are two other shallow grooves, which commence at the beaks and run along the posterior margin of the shell to the infero-posterior end; the beaks are very prominent, attenuated, and strongly incurved towards the front side; the surface is regularly concentrically striated and sulcated.

Locality.—Pondicherry, in bluish calcareous sandstone; rare.

Formation.—Valudayur group.

ANATINA, Lamk., 1809 (see p. 68).

✓ 1. ANATINA (CERCOMYA) ARCUATA, Forbes, Pl. III, Fig. 1.

1846. *Anatina arcuata*, Forbes, Trans., Geol. Soc., London, vii, p. 143, pl. 16, fig. 5.

An. (Cerc.) testa elongata, compressa, sub-æquilaterali; parte antica paulo altiori, ad marginem sub-rotundata; umbonibus postice versus incurvatis, anguste fissuratis; parte posteriori angustata, rostriformi, prope marginem superiorem obtuse bicarinata; superficie costis concentricis distantibus, antice elegantim arcuatis ac striis incrementi numerosissimis ornata, area postero-superiori solum minute striata.

Height of shell at the beaks	:	its length	...	...	...	0.24
„ „ anteriorly	:	„	...	...	...	0.35
Thickness „ „	:	„	...	...	...	0.14

The two rounded keels along the upper margin of the posterior side include an area which is merely striated, while the rest of the surface is covered with distant ribs and fine striæ, and this character of ornamentation distinguishes the present form from any other described from cretaceous deposits. The ribs are anteriorly broadly and somewhat angularly rounded, and in this respect the species again mostly resembles the jurassic *An. (Cerc.) spatulata*, Ag. The beaks are distinctly curved towards the posterior end, close together, and narrowly fissured.

Locality.—Pondicherry, in a pale bluish calcareous sandstone; rare.

Formation.—Valudayur group.

PHOLADOMYA, Sowerby, 1823 (see p. 70).

✓ 1. PHOLADOMYA CAUDATA, Römer, Pl. II, Figs. 10-11, and Pl. XVI, Fig. 19.

1839. *Corbula æquivalvis*, Goldf., Pet. Germ., pl. 151, fig. 15 (non *Ph. æqualis*, seu *æquivalvis*, Sowerby, 1823, Pusch, &c.).
1841. *Pholadomya caudata*, Römer, Verst. Norddeutsch. Kreidegeb., pl. 10, fig. 8, non *Gon.* (or *Ph.*) *caudata*, Ag., 1842).
1843. *Pholadomya caudata*, Römer apud Geinitz, Kieslingswalda, pl. 1, figs. 28-30,—*idem* Reuss.
1845. *Cardium caudatum*, Römer, Bronns' Jahrb. f. M. und Geol., &c., p. 388.
1846. *Poromya æquivalvis*, Forbes, Trans., Geol. Soc., Lond., vii, p. 141;—(*idem* Bosquet in Staring's *Bodem van Nederlands*).
1846. *Cardium lucerna*, Forbes, Trans., Geol. Soc., Lond., vii, p. 145, pl. 17, fig. 10.
1847. *Cardium caudatum*, d'Orbigny, Pal. de la voy. d'Astrolabe et Zeleé, pl. 4, figs. 25-26.
1847. *Cardita Goldfussi*, Müller, Petref. Aachner Kreidef., pt. i, p. 20.
1849. *Pholadomya caudata*, Geinitz, Quadersandstgeb., p. 148.
1850. „ „ d'Orbigny, Prod. ii, p. 234,—(*idem* Ryckholt and others).
1865. „ *æquivalvis*, „ Pict. and Camp., Pal. Suisse, 4^{me} ser., 3^{me} pt., p. 94.
1867. „ *caudata*, Röm., Eichwald, Leth. ross., 11^{me} livr., p. 769.

Ph. testa ovato-oblonga, tenui, tumida, sub-inæquilaterali, æquivalvi (?), postice paulo longiore, subcaudata et anguste hiant, umbonibus latis, incurvis instructa, in superficie costulis tenuibus, crenulatis, æqualibus, radiantibus, confertis, in parte postero-superiori obsoletis sed lineis puncturatis substitutis notata; cardine in valva sinistra lamina unica brevi, in valva dextra duabus infra umbonibus sitis fossa mediana separatis instructo; fulcris ligamenti parvis.

Height of shell	:	its length	...	...	...	...	0.77
Thickness	„	:	„	...	...	...	0.76

The shell is always strongly tumid, inequilateral, the posterior half being slightly longer, gaping, but rounded on both ends; the beaks are thick, prominent, and strongly incurved. The surface is covered with very numerous, equal, radiating and finely granulated ribs, except on the upper portion of the posterior end, where only a few radiating punctured lines are traceable. It was most probably on account of this punctured surface that Prof. Forbes thought the species to be a *Poromya*, but the small single lamina below the beaks of the left valve fitting in a groove of the other, or rather in one divided ridge, distinctly shows that the species is a *Pholadomya*.

In general aspect this and the allied species resemble *Cardium* (just as those of *Ceromya* are similar to *Glossus*), but the thin structure of the shell readily shows the distinction, even should it not be possible to examine the hinge.

Forbes and d'Orbigny both described the Indian form as *Cardium*, and already identified it with the European species. Indeed there is not the slightest distinction between our shell and that occurring in the upper cretaceous beds near Aachen, in Saxony, and Bohemia. Müller's statement, that the hinge of the Aachen specimens is perfectly identical with that of a *Cardita*, is an error. I have examined some specimens obtained through Dr. J. Bosquet and can testify the identity of the hinge with that of *Pholadomya*. I am not quite certain

whether the shell is perfectly equivalve, for in many instances I found the beaks of the valves somewhat shifted; this is so general that it would rather seem natural than accidental. The convexity of both valves is perfectly the same.

Locality.—In bluish and light brown sandstone near Parchairy, Serdamungalum, &c.

Formation.—Trichinopoly group.

In Europe the species has been observed in the upper cretaceous strata of the whole of Germany, in Russia, &c. I am by no means certain whether d'Orbigny's *Ph. (Cardium) Subdinense* is really a different species.

✓ 2. PHOLADOMYA CONNECTANS, *Forbes*, Pl. XVI, Fig. 29.

1846. *Ph. id.*,—Trans., Geol. Soc., London, vii, p. 140, pl. 17, fig. 5—*idem* auctorum.

Ph. testa ovato-elongata, inæquilaterali, antice breviori et rotundata, postice longiori ac sub-caudata, paululum angustiori, fere clausa; umbonibus prominulis, antice versus incurvis, latis, approximatis; superficie concentricè striato-sulcata, ac decem costulis radiantibus postice evanidis notata; margine inferiori umbonibus opposito sensim inflexo.

Height of shell	:	its length	...	...	...	...	0.52
Thickness „	:	„	...	...	...	...	0.43

This species differs from the next by a smaller number of radiating ribs, more broadly rounded anterior end and the indentation of the margin opposite the beaks; to this indentation extends from the beaks a groove, which is broad, shallow, and rather more conspicuous than other sulci separating the ribs. In front of the median groove there are three and behind it seven radiating ribs, but on one of the two valves there seems to be another small additional rib traceable on either side.

Locality.—Pondicherry. I have seen but Forbes' original specimen, of which I give a figure; the one supplied by Forbes representing this shell is a little shorter than it ought to be.

Formation.—Valudayur group.

✓ 3. PHOLADOMYA RADIATULA, *Stoliczka*, Pl. III, Fig. 5.

Ph. testa elongata, inæquivalvi, antice ac postice rotundata; margine superiori et inferiori subparallelis, umbonibus mediocriter prominentibus, incurvis, approximatis; superficie striis incrementi, confertissimis ac costulis tenuibus radiantibus numerosis in parte posteriori obsoletis ornata; terminatione anteriori angustatim—posteriori distincte, sed non precipue late, hiante.

Height of shell	:	its length	...	...	...	...	0.51
Thickness „	:	„	...	...	...	...	0.39

In the large number of thin radiating ribs this species approaches the lower cretaceous *Ph. elongata*, but is considerably higher in proportion to its length; this

height, the upper and lower sub-parallel margins, and the moderate convexity of the valves are the most striking distinctions of this shell as compared with other known *Pholadomyæ*, of which some tertiary species, like *Ph. Alpina* and *rectidorsata*, have the greatest resemblance to the Indian fossil. On the well preserved surface of the shell the ribbings are less distinctly perceptible than on the cast.

Localities.—Not uncommon in sandstone beds at Garudamungalum, Serdamungalum, and north of Alundanapooram.

Formation.—Trichinopoly group.

✓ 4. PHOLADOMYA PEDISULCATA, *Stoliczka*, Pl. IV, Fig. 1, and Pl. XVI, Fig. 26.

Ph. testa perlonga, sub-cylindracea, valde inæquilaterali, parte antica brevi, paulo inflata, radiatim multisulcata, ad terminationem hiante; superficie concentrice anguste sulcata, et minute striata ac interdum in parte mediana nonnullis costis sub-obsoletis notata, terminatione postica sub-truncata, hiante, sensim compressiuscula.

Height of shell	:	its length	...	...	...	...	0.45
Thickness	„	„	...	...	...	...	0.41

This is a remarkable type of a *Pholadomya*, quite distinct from any that have as yet been described. It is very long, considerably inflated, and towards the posterior end greatly compressed. The short anterior part is inflated, separated from the rest by a deep sulcus running somewhat obliquely from the front edge of the beak to the lower margin; it is provided with numerous and rather sharp radiating ribs, which form undulations at the small anterior gape; besides that there are in some specimens on the middle portion of the surface a few distant and rather indistinct ribs. The beaks are broad, not much elevated, but strongly incurved and almost touching each other. The lower edge of the shell is very slightly convex and the upper posterior slightly concave.

Localities.—In bluish calcareous sandstone near Garudamungalum and in brownish sandstone beds near Anapaudy.

Formation.—Trichinopoly group.

VI. Family,—SAXICAVIDÆ.

The animals have, like the *ANATINIDÆ*, the mantle margins united, with a small opening in front for the purpose of protruding a small digitiform foot; the siphons are united in their entire length, sometimes separated at their terminations; there are two pairs of gills on each side of the body, being occasionally slightly prolonged in the branchial siphon. The palpi are, as usually, triangular and striated; the arrangements of the other organs are identical with those of typical *MYACEA*.

The shells are of an elongated ovate form, usually inequilateral and equivalve; they are thick, externally highly calcareous, and internally sometimes perlaceous, covered with an epidermis, which extends over the siphons, and in some respect

represents the calcareous tube of the *PHOLADACEA*. The hinge is usually composed of a few teeth and pits, which occasionally become entirely obsolete in full grown specimens; there is an external ligament present supported by special nymphæ, but the cartilage is either rudimentary (*Cyrtodaria*) or altogether wanting; the pallial line is deeply insinuated posteriorly.

The recent genera referable to this family are *Saxicava*, *Panopæa*, *Glycimeris*, and *Cyrtodaria*, as recorded in H. and A. Adams' "Genera of recent shells," with the exception that the names *Panopæa* and *Glycimeris* are here used in a reverse sense.

A list of the recent species of the *SAXICAVIDÆ* has been lately published by Tryon in the 4th vol. of the American Journal of Conchology; there are nine *Saxicavæ*, eight *Panopææ* (*Glycimeris*), two *Glycimeris*, and two *Cyrtodariæ* mentioned.

The great resemblance which exists in the form of the finger-like foot and the united siphons, enveloped in a more or less coriaceous epidermis, and in the form of the shell of *Saxicava* and *Rocellaria* or *Spengleria*, has been so often noticed that it is not necessary to relate it here again. Forbes and Hanley, in their history of British Mollusca (i, p. 137,) state that it would often be almost impossible to distinguish generically between some of the varieties of *Saxicava rugosa* and some *Rocellariæ* were the history of the species unknown. The mode of life also is in both families quite similar, and the only difference is the absence of a special calcareous tube in the *SAXICAVIDÆ*. Thus, as regards the genus *Saxicava*, the place which is usually assigned to this family—next to the *GASTROCHÆNIDÆ*—cannot be better justified. But when we look upon the other genera, such as the palæozoic *Notomya*, the *Panopææ* and others, there is a still greater relation between these genera and those of *Homomya* and *Pholadomya*, than between them and the *GASTROCHÆNIDÆ*. Again, *Cyrtodaria* appears to indicate a natural passage to the *SOLENIDÆ*, and thus the most natural position of the family seems to be that somewhat intermediate between the last named family and the *ANATINIDÆ*.

With the exception of *Notomya*, *Anthracosia*, and *Quenstedtia* nearly all the fossil forms of this family appear to belong either to *Saxicava* or *Panopæa*, and the former genus is, on account of its external resemblance to *Trapezium*, often rather difficult to be made out. It scarcely appears to have been formerly more numerous than it is now. Of *Panopæa*, however, there are a very large number of species known from mesozoic deposits, but in external shape again they are allied to numerous other genera, as *Homomya*, *Myacites*, *Pleuromya*, and others. Many of the triassic species described as *Panopæa* seem mostly to belong to these last named genera, because they have a remarkably thin shell, such as we find in *Pholadomya* and other *ANATINIDÆ*. Whenever we have to deal with casts, and where the impressions of the hinge are not traceable, the determination must remain conjectural. I merely need to allude to the numerous mesozoic species, which in most cases are only found in the shape of casts.

As regards species, the largest number of fossil *Panopæa* probably occurs in the cretaceous period, for of those from jurassics, as already stated, many belong to the

ANATINIDÆ; in the tertiary period the number rapidly decreases, and of recent there are about eight distinct species upon record. Like all such forms, of which Prof. Forbes says that they belong more to past ages than to the present fauna, they have a wide geographical distribution, being scattered in small numbers over the whole world. In addition to the recent genera I shall mention a few fossil (palæozoic and mesozoic) forms, which are more or less closely allied to the former.

1. *Notomya*, McCoy, 1847, (Ann. Mag. Nat. Hist., xx, p. 303). Shell transversally oval, sub-equivalve, inequilateral, solid, slightly gaping at both ends; hinge with one strong tooth in the right valve, which appears to correspond to a pit in the left; the two muscular impressions are large and deep, a third, small accessory one is situated above the anterior large one; pallial sinus very small, or only indicated by a truncation of the pallial line; ligament strong external.

This appears to be one of the oldest forms of *Panopæa*, first described from the palæozoic rocks of N. South Wales. The characters of the genus are not very clearly defined, but from what is now known of these shells it seems impossible to class them in any other family. McCoy appears to me to have been perfectly correct in pointing out the relation of these shells to the *Myæ*; and as his characteristic is far more intelligible than that given by Dana of his *Mæonia*, I think it advisable to accept his name. Great confusion exists among the fossils which have been described from the N. South Wales palæozoic (carboniferous?) rocks, and some of the species, described as *Notomya* or *Mæonia*, may just as well belong to *Pachydomus*, and *vice versâ*.

Dana described (? published) a few months earlier than McCoy, several species from N. South Wales under the new generic names of *Myonia*, *Cleobis*, and *Pyramus*. In his Geology of the Unit. St. Expl. Exp., vol. x, 1849, p. 694, he accepts only one generic name, *Mæonia*, and divides this into three sub-genera, *Mæonia*, *Pyramia*, and *Cleobis*, of which the author pronounces the second to be identical with *Notomya* of McCoy. This is a delicate way of dealing with generic names of shells! Neither in the text nor in the atlas does Mr. Dana mention which of the species belong to each of the three sub-genera; and from the descriptions and the figures the reader will find it very difficult to arrive at anything like accuracy of determination. I have examined several specimens of various species, but I cannot for instance trace a generic distinction between *Pachyd. cuneatus* and *Mæonia axinia* of Dana. Again, such species, as *Mæo. valida* and *M. grandis* or *M. gigas*, the first of which are strong *Crassatella*-like, the others thin *Homomya*-like shells, very improbably belong to the same genus (even should it be in the Lamarckian sense), but more likely to altogether different families.

2. *Anthracosia*, King, 1856, (non 1844), (Ann. Mag. Nat. Hist., xvii, p. 51). Shell oval, equivalve, inequilateral, solid; hinge with one thick, horizontally elongated tooth in the left valve fitting into a strong excavated tooth of the right valve; ligamental fulcrum large, corrugated, and situated just above the hinge and below the beaks, somewhat extending posteriorly: Type *An. Beaniana*, (loc. cit., pl. iv,

figs. 1-4). Prof. King strongly advocates the idea that *Anthracosia* is a genus of the *UNIONIDÆ*, but there can be little doubt as to its close relation to *Notomya*, and it is even very difficult to distinguish between some of the species generically. The ligamental area of *Anthracosia* much more recalls that of *Panopæa* and *Cyrtodaria*, than that of any known *UNIONIDÆ*; and as Salter distinctly asserts that it is a marine or brackish water shell, I think its classification in this place may be the more correct one. The name *Anthracosia* has as yet been restricted to palæozoic species only.

3. *Quenstedtia*, Morris and Lycett, 1853, (Moll. Great Ool., pt. II, p. 96). Shell oblong, equivalve, moderately solid, inequilateral, umbones nearly contiguous, hinge with a transverse cardinal tooth in the left and a corresponding pit in the right valve; ligament external, placed in a long narrow groove, pallial sinus small. Only a few jurassic species have as yet been referred to this genus; its systematic position is doubtful; it is allied to the *SAXICAVIDÆ* by its hinge and to the *ANATINIDÆ* by the form of its shell, and it may be considered intermediate between *Saxicava* and *Notomya* in respect of its dentition.

4. *Paramya*, Conrad, 1862 (?). Under this name Conrad introduces into the family *SAXICAVIDÆ* a small shell which he formerly described as *Myalina subovata* from the miocene beds of Virginia (see Proc. Acad. Phil., 1862, p. 572). The species which has the general form of a *Saxicava* or of a *Trapezium* (*Cypricardia*) is described as possessing a small spoon-shaped, emarginated process in each valve. It is not stated whether it indicates the presence of a cartilage or not; reference is made to the muscular and pallial impressions, but their form is not described.

5. *Saxicava*, Fl. d. Bellv., 1802.* Shell elongated, rugose, posteriorly gaping, anteriorly nearly perfectly closed, adult specimens have the right valve sometimes larger than the left; hinge with one tooth (occasionally two) in each valve, becoming sometimes obsolete in aged specimens, when the shells usually assume a great thickness; ligament small, not prominent; pallial sinus moderate and often indistinct;—usually burrowing in stones and corals.

The animal has the siphons separated at the end with fringed orifices, but is in other respects very similar to that of *Rocellaria*.

With regard to this genus it deserves to be noticed that the hinge-teeth do not in all cases become obsolete with age, as often stated in the generic character of this genus; several of our eastern species (*S. similis* and others) have them permanent and perfectly similarly formed to those of *Panopæa*.

* Agassiz and Herrmansen attach to *Hiatella* of Daudin 1802 as the date of publication, and this would sufficiently justify the adoption of the name *Saxicava* in preference to that of *Hiatella*, simply because the former name has become generally known and has already been introduced in all the larger conchological works. Chenu (Man. II, p. 25,) gives the year 1799 as the date of publication of the name *Hiatella*, but I have not been able to find the authority for this quotation. Deshayes (Paris foss., 2nd edit., I, p. 167,) gives 1801 as the year in which the name *Hiatella* was published, quoting as authority the "l'histoire des coquilles" of Bosc, the same as cited by Agassiz and Herrmansen.

6. *Panopæa*, Ménard, 1807.* Shell nearly equivalve, large, oblong; hinge with one strong tooth in each valve, pallial impression distinct, posteriorly deeply insinuated, ligament supported by prominent fulcra;—burrowing in sand.

It is really difficult to point out a prominent distinction between *Saxicava* and *Panopæa*, except that the latter generally are less inequilateral shells and of large size; and in proportion all the characters of *Panopæa*, as pallial sinus, hinge-teeth, and the fulcra of the ligament, appear more distinctly marked; their habitat is also somewhat different.

H. and A. Adams, in their work on the recent genera of Mollusca, correctly distinguish between *Glycimeris* and *Panopæa*, but their application of the names is based upon an incorrect interpretation and cannot, therefore, be retained. The name *Panopæa* was proposed by Ménard for a tertiary species, which he calls *P. Faujasi*, but which has been proved to be identical with the recent *P. glycimeris* of Born, or *P. Aldrovandi*, Mén., and this species H. and A. Adams refer to *Glycimeris*, retaining the name *Panopæa* for *P. norvegica* of Spengler. Thus the name *Panopæa* evidently cannot be used for the Norwegian species, but when we consider that Klein in his admirable "Tentamen" already refers to a Norwegian species, which is probably the *P. norvegica* of authors, and, further, that Deshayes described that species (in the 2nd edit. of the Anim. s. vert.) under the generic name of *Glycimeris*, I am not certain whether it were not preferable to retain that generic name for it instead of creating a new one. For I believe there is sufficient reason for placing the Norwegian species in a new genus, which connects the true *Panopææ* with *Cyrtodaria*, as I shall presently point out.

7. *Glycimeris*, Klein, 1753, (Tent. meth., p. 170, *Panopæa* apud H. and A. Adams). Shell thick, nearly equilateral, hinge with one tooth in each valve, fitting into a special cavity in the other valve; pallial line interrupted, moderately insinuated, posterior muscular impression very elongated.

In conformity with the few distinctions in the animals of *Panopæa* and *Glycimeris* (*Gl. norvegica*), pointed out by H. and A. Adams, those of the shells are, I think, deserving of a special notice. The shell of *Gl. norvegica* is not only

* To prevent further confusion I adopt here Ménard's name *Panopæa*. The recent species, which is the type of the genus — *P. Aldrovandi* — has been, besides several others, well known to the oldest writers on conchology. Klein in 1753 was the first who classed several of the species [the Norwegian one being evidently known to him] under the generic denomination of *Glycimeris*. Klein gives a figure of one species and quotes next the *Chama glycimeris* of Aldrovandi, but having applied the name *Chama* previously to another group of shells, Klein was perfectly aware that a new generic name was required. Thus as far as the generic name is concerned, it was perfectly in accordance with our present system of nomenclature. And, what notice did Klein's well selected name *Glycimeris* receive from his successors? Mr. Deshayes (in his 2nd edit. of the Paris fossils, p. 172,) tells us, that Lamarck, struck with the peculiar characters of Born's *Mya glycimeris* (= *Chama glycimeris*, Aldrov.) proposed in 1799 a new genus *Glycimeris*! A few years back Lamarck applied the name *Glycimeris* to a perfectly different shell, which Daudin called *Cyrtodaria*. And, again, after a few years, when Ménard proposed his name *Panopæa*, Lamarck dropped the name *Glycimeris* altogether. Whether Lamarck was, or was not, (which latter would be surprising) acquainted with Klein's "Tentamen meth.," &c., it is clear that he was not the author of the genus *Glycimeris*, but this name has been so unjustly treated and differently applied, that I do not for a moment see any benefit to science in introducing it again in a sense different from that generally adopted; still when facts are to be given, it is just to former labourers to give them in full.

distinguished by its marked solid structure and the interrupted pallial line, but especially by the very elongated and curved form of the posterior muscular impression, which in *Panopæa*, as here restricted, is always rounded. The pallial sinus also is in both genera very different; further, we have in the hinge of *Panopæa* in each valve one tooth which fits into a simple emargination of the inner hinge margin, while in *Glycimeris (norvegica)* we have a tooth which fits into a special depression of the frontal area of the hinge. Considering these characters, which are quite as well expressed in the tertiary form, as they are in the recent one, I believe there is sufficient reason for a generic distinction.

8. *Cyrtodaria*, Daudin, 1799. Shell solid, rather compressed, gaping at both ends, more widely in front, equivalve, inequilateral, the posterior portion being much shorter than the anterior; pallial line interrupted and irregular; sinus very small; hinge-region thickened, but without teeth; fulcra supporting the ligament strongly prominent. The surface of the shell is covered with a thick epidermis, which has quite the character of that of the *SOLEMYIDÆ*, and forms a passage to the *SOLENIDÆ*. With this last named family,—at least with several typical genera belonging to it, as, for instance, *Tagelus* and others,—*Cyrtodaria* has in common the shortness of the posterior region of the shell. The resemblance is still more prominent when we compare with it old specimens of *Tagelus* or *Novaculina*, in which the hinge-teeth have become obsolete, which is by no means unusual. The internal structure of the shell with its irregular pallial line and the form of the animal clearly point out the great resemblance of the present genus to the previous one.

There is, as I have already noticed, a gradual change to be observed in the position of the beaks in the different genera of this family. In *Cyrtodaria* they are situated at about one-third of the total length from the posterior end, in *Glycimeris* they are nearly central, in *Panopæa* they are placed at about two-thirds of the total length from the posterior end, and in *Saxicava* they are almost anterior.—Only one recent species of *Cyrtodaria* is known to inhabit the arctic regions. In external form it undoubtedly closely resembles *Solemya*, and the latter could be treated of in this place were the animals not so thoroughly different from each other. The animal of *Solemya* is allied to that of *Crassatella*, and though the two genera are at present as thoroughly distinct as two shells could possibly be, there are a number of very old fossil forms, like *Orthonota*, *Leptodomus*, *Sedgwickia*, and others, which appear to connect both.

LIST OF CRETACEOUS SPECIES.

For reference to the species known from cretaceous rocks see Pictet and Campiche, Pal. Suisse, 4^{me} ser., 3^{me} part., p. 67, &c.

1.—*Saxicava antiqua*, d'Orb., is only known by a phrase insufficient for the identification of the species. Dujardin also suggested that a cast of a small species from cretaceous beds of the Touraine may belong to a *Saxicava*.

2.—*S. Carolina*, n. sp., occurs in our South Indian cretaceous deposits.

PANOPÆA.

Pictet and Campiche state (loc. cit., p. 46,) that all the species referred to Agassiz's *Myopsis*, which Terquem has shown to be in part the same as *Pleuromya*, differ from this genus by

showing the impressions of the teeth of *Panopæa*, and therefore belong to the last genus and not to *Pleuromya*. Our materials are not sufficient to allow of our inquiring into this statement, but it seems quite certain that in many of the cretaceous *Panopæa* the shell is much thinner than in any recent species of that genus, and the strong fulcra supporting the ligament are sometimes perfectly wanting. I am rather confident that among these cretaceous *Panopæa* there are many *Homomya*, *Pleuromya*, and even *Poromya*. To quote only one instance: I certainly do not know where such a finely striated and punctated surface is to be observed on a recent *Panopæa*, as is to be seen on *Panop. neocomiensis* and some other species. Besides this several lower cretaceous species are so very similar to each other, that one would be inclined, from the existing descriptions and figures, to reduce them to at least one-half the present number. Most of them have been examined by Pictet himself, but apparently not with much success; the examination of the originals is in this case indispensable and certainly very desirable, for to settle these generic differences would be a great gain to conchology; it would also extremely facilitate the determination of our mesozoic *Myacea*.

3-21.—(Neocomien species); *P. Neocomiensis*, Leym., *arcuata*, Ag., *Robinaldina*, d'Orb., *Albertina*, d'Orb., (perhaps=*cylindrica*, P. and C.), *accuttisiodorensis*, Cott., *rostrata*, Math. (= *arcuata*, d'Orb.), *lateralis*, Ag., *irregularis*, d'Orb., *Cottaldiana* and *Carteroni*, d'Orb., *lata*, *attenuata* and *curta*, Ag., *cylindrica*, P. and C., *Dupiniana*, d'Orb., *Voltzii*, *Urgonensis*, *Massiliensis* (?=*attenuata*), *cuneata* (?=*lata*).

22-27.—Eichwald (Leth. Ross., livr. XI, p. 777, &c.) quotes from the Neocomien (Jurassic in part) *P. peregrina*, d'Orb., *Keyserlingi*, d'Orb., *borealis* and *antiqua*, Eich., *Qualeneana* and *Lepecheniana*, d'Orb. The same author also quotes *neocomiensis* (= *Orbignyana*, Rouillier), *lata*, *Prevostii*, *acutisulcata*, *lateralis* and *carteroni*, the last from cenomanien beds and the preceding simply from a 'cretaceous marl.'

28-31.—(Aptien species); *P. Prevostii*, Desh., d'Orb., (*non plicata*, Sow.), *P. nana*, *fallax* and *Aptiensis*, Coquand (Étage Apt. de l'Espagne, 1865, pp. 89-90, &c.). The last two species may be *Poromya*. Coquand also quotes *plicata*, Sow., from Spain, and identifies Römer's *plicata* with Leymerie's *neocomiensis*, which I do not think at all correct, that species being possibly the same as Brongniart's *gurgitis* and most likely a *Pleuromya*.

32-40.—(Gault species); *P. Römeri*, Gein., *acutisulcata*, Desh., *plicata*, Sow., (is more inflated than d'Orbigny's *plicata*, which also has the anterior side a little longer, in which respect it resembles *acutisulcata*, of which Piet. and Camp. suggest it may be only a variety), *Arduennensis*, *Constantii* (? *Pleuromya*) and *inæqualis*, d'Orb., *Saubadiana*, P. and R., (? *Poromya*), and *Rhodani*, Piet. and Roux (Foss. gres. vert., p. 400, omitted in the Prodrôme and consequently also in Pictet and Camp.'s list).

41-54.—(Middle and upp. cretaceous species); *P. mandibula* (= *Beaumontii*, Münster.= *Jugleri*, Römer; I think Geinitz is correct in identifying these); *gurgitis*, Brong. [this is said by Pictet and Campiche to have been based upon a species from Perte-du-Rhône, and may prove to be the same as *neocomiensis*; Brongniart's figure certainly does not represent a shell which could possibly be *neocomiensis*, though he may have applied the name to such a form. Römer's *P. plicata* is similar in form to Brongniart's *gurgitis*, but is less high posteriorly and the surface is punctated; it more likely belongs to *Pleuromya*. D'Orbigny's and Reuss' *P. gurgitis* is to all appearance the same as Goldfuss' *plicata*, and most likely will have to receive a new name]. *P. laeviuscula* and *ovalis*, Sow. sp., *substriata*, d'Orb., (a *Pleuromya*!); *Asteriana*, d'Orb. (a *Poromya*!); *elatior*, *regularis* and *Normaniana*, d'Orb., *cretacea*, Math., *elongata*, Röm. (*non Lut.* [? *Panopæa*] *elongata*, Münster, from the oolite); *Ewaldi*, Reuss, (is very like Matheron's *cretacea*); *sinuata*, Reuss; *Goldfussi*, d'Orb.; this last name was suggested for the species described by Goldfuss as *gurgitis*, (Brong.), and which appears to be identical with Nelson's species of the same name; both are a good deal like *plicata*, Sow.

55-56.—*P. acuminata* (? *Homomya*) and *P. æqualis* are described by Schafhäutl from the same beds in which cretaceous fossils according to him also occur, but the exact position of the fossil is unknown (see Süd-Bayern's Leth. Geog., 1863, p. 174).

57-58.—*P. rustica* and *frequens*, Zittel, are from the Alpine Gosau formation (Denksch. Akad., Wien, 1865, XXIV, pt. II, p. 110, &c.). The first in form somewhat resembles Sowerby's *læviuscula*, the second may be, as already stated, a *Poromya*.

Eichwald (Leth. Ross., XI, 1867, p. 781, &c.) also mentions from the cretaceous beds of Russia *P. regularis* and *striata* (= *substriata*).

59.—Bosquet (Staring's bod. v. Nederland, II. deel.) quotes, besides *P. Goldfussi* and *Esmarki*, a *P. Santi-Petri*; I am not acquainted with that species.

60-67.—Meek (Smith. Mis. Coll., No. 177,) quotes from North America *P. decisa*, *Newberryi*, *occidentalis*, *subplicata*, *subparallela*, *texana*, *Tuomeyi*? *Pachymya austenensis*, which is more probably a species of the *MYIDÆ*, (see p. 67), and *Pan. concentrica*, Gabb., from the Californian cretaceous deposits; this last is, however, subsequently (Pal. Calif. II) referred by its author to *Homomya*.

P. decisa of Conrad has been referred by Gabb to *Cyrtodaria* (= *Glycimeris*), but unless Conrad's figure and description is very incorrect the species cannot belong to that genus.

68.—Conrad describes (in Offic. Rep. of Lynch's expedition to Palestine) *P. pectorosa* and *orientalis*, which I only know by name and cannot say whether the second one is considered identical with the Indian species.

69.—*P. orientalis*, Forbes, is the only species which occurs in Southern India.

70.—*P. Nagorzanyensis*, Favre, (Desc. Moll. foss. de Lemberg, 1869, p. 104, pl. xi, fig. 9), is from the upper cretaceous beds of Galicia.

SAXICAVA, *Fl. d. Bell.*, 1822, (see p. 84).

1. SAXICAVA TENELLA, *Stoliczka*, Pl. XVI, Figs. 20-24.

Sax. testa transversaliter elongate-ovata, inæquilaterali, pertenui, umbonibus minutis sub-anticis, in superficie striis minutis incrementi instructa; valvulis sub-inæqualibus, moderate tumidis, dextra paulo majori; cardo in valvula dextra dentibus duobus quorum superior minutus, in val. sinistra dente unico instructus, nymphis parvulis.

Height of shell : its length	...	...	...	...	0.58
Thickness „ : „	...	...	...	...	0.22

The shell of this species is remarkably thin, sometimes almost hyaline, very finely concentrically striated; the beaks are prominent and situated at nearly one-third of the total length from the anterior margin; the right valve is a little larger than the left, as, for instance, in adult specimens of the recent *S. similis*, Desh.; the hinge in the right valve has two teeth, one stronger below and a little in front of the beak, and one smaller above and anterior to it, the latter being, strictly speaking, only a slight projection of the shell margin; the left valve has one small tooth below the beak; the nymphæ are small, but more distinct in the left than in the right valve.

Locality.—North of Odium, not uncommon in a dark brown somewhat sandy limestone.

Formation.—Ootatoor group.

PANOPÆA, *Ménard*, 1807 (see p. 85).✓ 1. PANOPÆA ORIENTALIS, *Forbes*, Pl. II, Figs. 1-4.

1846. *Panopæa orientalis*, *Forbes*, Trans., Geol. Soc., Lond., vii, p. 139, &c.—*idem* auctorum; (nomen *P. orientalis*, *Con.*, (Off. Rep. in *Lynch's Exped.*, Palæst., dubiosum).

P. testa ovato-elongata, valde inæquilaterali, parte antica multo breviori, sulco lato sed haud profundo ab apicibus ad marginem inferiorem subrecte decurrente separata, lateribus anterioribus rapide declivis, infra hiantibus; parte postica gradatim plus minusve attenuata, ad terminationem rotundata ac late hiantes; superficie striis minutissimis ac sulcis costulisque angustis, imprimis prope apices distinctis notata.

Greatest height of shell	:	its length	...	...	...	0.64
Thickness	„	„	...	...	...	0.48

The form of the shell of this species is very characteristic, but as regards the posterior attenuation somewhat variable; the anterior part of the shell is truncated in front and separated from the posterior by a broad, though shallow, furrow extending from the beaks to the antero-inferior margin. The middle portion of the lower edge is convex; the concentric sulcations are as usually most distinct near the beaks; the fulcra are long, thickened, but not very prominent. The right valve has an erect tooth in front of a pit to which the tooth of the left valve corresponds.

Localities.—Anapady, Koloture, Serdamungalum, North of Alundanapooram, &c., and south of Arrialoor; mostly in bluish, brownish, and whitish sandstones.

Formations.—Trichinopoly and Arrialoor groups; very common in the former, rare in the latter.

VII. *Family*,—GLAUCONOMYIDÆ.

The animals of the species belonging to this family are, in external appearance, very similar to those of the MYINÆ on the one side and the ANATININÆ on the other; they have the mantle margins united, open anteriorly for the protrusion of only a small, more or less elongated foot; the gills are double, rounded, about half the length of the body, and one-third longer than the palpi, which are broadly falciform. The gills are not prolonged into the siphons* which are united up to the end, with the orifice free and fringed; they are enveloped in an extension of a more or less thickened or coriaceous epidermis which covers the shell, similarly as in *Mya* or *Anatina*. At the base of the siphons there is a very small opening in the mantle through which a portion of the water which enters the body is at intervals ejected with force, while the current in the in-and ex-haling siphons is a more regular and continuous one. A similar opening below the siphons is also found in *Novaculina* (and several other SOLENIDÆ), serving the same purpose.

* In *Glauconomya cerea*, which is found along our sea coast, Mr. W. T. Blanford tells me the siphons are rather thin and of nearly double the length of the body. This coincides with an observation I lately made on a species occurring on the sandy beach at Arracan.

The shells are in form intermediate between the *SAXICAVIDÆ* and the *SOLENIIDÆ*; they are elongated, inequilateral, occasionally slightly nacreous inside, with the pallial impression sometimes partially interrupted, or undulating, and with the pallial sinus deep. The hinge has numerous teeth in each valve; there is a very thin cartilage substance present, situated above the posterior laminar teeth, and besides a strong ligament externally above it, partially covering the same and somewhat internally attached behind it posteriorly. H. and A. Adams place this family in the *VENERACEA* next to the *PETRICOLIDÆ*, which can scarcely be admitted as correct. The animals of both *Glaucomya* and *Tanysiphon* which I have examined are, as I stated, externally much like those of *Mya* or *Anatina*, while in the *PETRICOLIDÆ* we find two short sub-equal siphons separated for the greater part of their length, and not covered with the epidermis of the shell, which in the *GLAUCOMYIDÆ* forms a regular tube over the siphons. These are, however, fully retractile within the shell, as we find them in the *SOLENIIDÆ*, *MACTRIDÆ*, and some species of the *ANATINIDÆ*, while in other allied forms, like *Anatina* or *Cyrtodaria*, the siphons are not perfectly retractile.

The only resemblance existing between the *GLAUCOMYIDÆ* and *PETRICOLIDÆ* lies in the dentition of the hinge, not in the structure of the shells, which are thin and somewhat pearly in the former, thick and solid in the latter. The anterior hinge-teeth are in both no doubt similar, but they do not, on the other hand, differ essentially from the hinge-teeth of *Novaculina*. In the *PETRICOLIDÆ* the single one or two posterior teeth fit closely beside each other, exactly as do the anteriors when the valves are closed; but in the *GLAUCOMYIDÆ*, the posterior teeth are bifid, their smaller portions fitting one above the other, and the hinder larger portions possess flat surfaces for the attachment of a thin white cartilage. This last is very distinct in *Tanysiphon*, in which the ligament is small, but in *Glaucomya*, in which the cartilage becomes sometimes quite obsolete, the ligament predominates. For this reason I do not wish to lay too much stress upon the presence or want of a cartilage. The greatest resemblance which I can find, as regards the structure and general character of the shell of *Glaucomya*, is that with *Standella* (of the *LUTRARIINÆ*); the cartilage processes are, of course, very different, but there actually is a perfect analogy between both in their position with reference to the external ligament.

In habitat the *GLAUCOMYIDÆ* mostly resemble the *SOLENIIDÆ*; both burrow in sand and mud, and most of the species live in brackish water; they appear to be confined to the waters of the Eastern, especially the Indian seas. I have observed several species of *Glaucomya* burrowed in sand between tide-marks; they seemed to prefer particularly those localities where a small stream of fresh water enters upon the beach. Thus comparing all these characters of the shells and the animals, I do not think they are in favour of the classification of the *GLAUCOMYIDÆ* in the *VENERACEA*, but that they clearly indicate a position near the *SAXICAVIDÆ*, forming in many respects a transition from these to the *SOLENIIDÆ*.

There are at present only two genera, *Glaucomya* and *Tanysiphon*, sufficiently well known to be placed in this family, but it appears to me probable that this

small number will have to be considerably enlarged when the animals of some other genera have been examined.

I would here particularly draw attention to the genus *Clementia*, Gray, 1840, (see H. and A. Adams' Genera, ii, p. 433). The shells in general character and in the dentition of the hinge very much resemble some *Glaucomya*, and there appears to be a kind of a white cartilage mass situated in a deep open groove behind the beaks, covered up by the ligament which extends backwards. The pallial sinus of *Clementia* is quite similar to that of *Dosinia*, and according to the statement of H. and A. Adams the animals of both would also seem to be similar; the genus must, therefore, be for the present retained in the sub-family *DOSINIINÆ*. I am sorry to say that I have not yet had an opportunity of observing the animals of *Clementia*, but the character of the shell with its pale olivaceous epidermis is certainly nothing like what we are accustomed to see among *DOSINIINÆ* (*vide postea*).

I do not know the typical species of *Naranio*, Gray, but from the description of the species *N. rubiginosa* (Proc. Zool. Soc., 1863, p. 425, pl. 37, fig. 17), it would appear that the genus is closely allied to *Clementia*; H. and A. Adams ("Genera") consider, however, *Naranio* as identical with *Choristodon*. And lastly, I may mention here the genus *Blainvillia* of Hupé, of which I already spoke in the *MACTRIDÆ* (see p. 54).

1. *Glaucomya*, Bronn, 1838, (*Glaucome*, Gray, non *idem*, Goldfuss, Defrance, &c.). Shell subtruncate or somewhat attenuated behind, slightly inequivalve and inequilateral; hinge composed of three oblique teeth in each valve, those of the right generally larger than those of the left, the last bifid tooth is more oblique than the others. Margin behind the beak thickened, adapted for the support of a long external ligament, the posterior end of which is attached internally at the end of the nymphæ; pallial sinus narrow and long, but generally not extending as far as the beaks; surface of shell covered with a green imbricated epidermis.

There are about 18 recent species known of this genus, all estuary or littoral.

2. *Tanysiphon*, Benson, 1858. Shell small, oval, subtruncate behind, covered, like that of *Glaucomya*, with a dull greenish epidermis; pallial sinus broad and extending as far as, and sometimes beyond, the region of the umbones; hinge with three teeth in each valve, almost perpendicular, the anterior two in the left valve smaller, the last being in both the largest, short, and broad, more resembling a cartilage process of the *MYIIDÆ* than a simple tooth; ligament external very short, its posterior end attached internally behind the cartilage. The external form of *Tanysiphon* is the same as that of *Glaucomya*, but the hinge differs in the direction of the teeth and the form of the cartilage processes, &c., &c.

There is as yet only a single species, *T. rivalis*, Benson, known, which was found near Calcutta in a canal (Tolly's-nullah) subject to the influence of tide, the water being generally a little brackish. The species is common here; but very rarely occurs in other places of the Sundarbans. I met with another species on the Arracan coast and found also some imperfect valves at Penang.

There are no fossil species known of either of the two genera, but among the various forms of the jurassic *Myæ* there are several which externally greatly resemble *Glaucomyæ*; the knowledge of the hinge-teeth is essential for their correct generic determination, the external shape of the shells being in such cases entirely unreliable.

VIII. *Family*,—*SOLENIDÆ*.

The animals included in the present family are distinguished by their great length in proportion to their height. The mantle is united, except in front and behind, for the respective passages of the foot and the siphons. On account of this great length and cylindrical form of the body the *SOLENIDÆ* are usually classified next to the *PHOLADIDÆ*, although on closer inspection the relations are by no means so clearly understood. In the *PHOLADIDÆ* we have always a small pointed foot, and the posterior part of the body in which lie the gills greatly elongated, none of which are found in the *SOLENIDÆ*. With regard to the last organ, the gills as well as respecting the habits of the animals,—(and the same applies to the form and character of the shell, as already noticed)—their closest allies unquestionably appear to be the *GLAUCOMYIDÆ* and *SAXICAVIDÆ*. On the other hand, the *SOLENIDÆ*, all have a long, very strong foot, which often occupies half the length, or more, of the entire body; the siphons become sometimes perfectly divided from their bases to their terminations, as, for instance, in *Novaculina*, and thus very much recall some of the elongated forms of the *TELLINIDÆ*. In fact some of the species of *Solecurtus* and *Siliqua* indicate through the form of their shell and its dentition on the hinge a direct passage from the present to the next family. For these reasons I prefer rather to follow in the present arrangement of the *SOLENIDÆ* the one adopted by Forbes and Hanley in their admirable "History of British Mollusca," than that of more recent writers.

The foot of the *SOLENIDÆ* consists of a strong muscular tissue, and is, according to the observations of Clark, provided in almost its entire length with an aquiferous canal. When protruded out of the shell it is clavate in front, but when employed in burrowing its termination can extend into a linguiform point, which by being twisted from one side to the other forms hollows in sand, in which the animal can burrow with the greatest rapidity. Deshayes has observed that the animal possesses besides the power of progressive motion. It fills its body with water, and by ejecting the same forcibly through the siphons darts from one place to the other, till it can find a convenient one to burrow in. I have had opportunity of observing this kind of motion repeatedly in *Pharella*, *Novaculina*, and others, but the greater part of the water was during this kind of progressive motion ejected through the opening below the siphons, rather than through the exhaling siphon itself. The mouth is surrounded as usual by triangular palpi, generally of no considerable size. The siphons are either united nearly the whole of their length, as in the *SOLENINÆ*, or more or less separated, as in the *PHARELLINÆ*. The other characters of the animals

and shells of these two sub-families are, however, so perfectly similar, that a separation into two families, as proposed by some authors, would seem unnatural. For instance, the shells of some of the species of *Pharella* and *Novaculina* are so closely allied, that it is very difficult to distinguish them generically, even as regards the dentition of the hinge, but in *Pharella* the siphons are united nearly up to the end, as in *Solen* proper, while in *Novaculina* they are separated for their entire length in a way only to be found in species of *Tellina* or *Scrobicularia*. The length of the siphons varies in different species of the same genus; so, for instance, they are in *Nov. gangetica*, usually three times as long as the shell, while in another closely allied species from the neighbourhood of Calcutta, I never observed the siphons longer than about equal to half the length of the shell. In living animals there is a constant current of water observable, entering the lower siphon and exuding from the upper one. The anus terminates in the upper siphon. From time to time the animal of *Novac. gangetica* is seen to close both the ends of the siphons and then eject a large quantity of water from the opening just behind the base of the foot. Whether the water previously enters at the same place, or whether it is merely a surplus of that entering through the inhalant siphon, I have not as yet been able to ascertain.

The shell of all *SOLENIDÆ* is covered with an epidermis, which encloses both the valves, being open only in front and behind; it, however, only partially extends beyond the posterior end over the siphons. The valves are long, and, as a rule, quite equal; the hinge-teeth small, and often thin and laminar, sometimes obsolete, as in the *SAXICAVIDÆ*; the ligament external, immediately behind the beaks supported by slightly prominent fulcra; no cartilage is present, but the ligament is often spongy and soft internally.

The habits of the so-called razor-fish are too well known to need any further notice; they possess a world-wide distribution, and live usually in mud or sand between the tide-water marks. A large number are found in tropical and subtropical countries in tidal rivers, and some can live for a time even in fresh water, though they soon degenerate in it. Some of the best accounts about this family may be read in Forbes and Hanley's works and other treatises; very valuable information on this subject is also contained in Deshayes' last edition of the Paris Fossils.

Geologically, the *SOLENIDÆ* belong to the oldest families of *Pelecypoda*; they are represented in palæozoic rocks, though sparingly. Their number and variety increases very gradually through the succeeding formations, and they have their maximum of development during the present epoch.

H. and A. Adams, and others, distinguish two sub-families, which are indicated, though by no means very clearly defined, by some differences in the organisation of the animals. They are not accepted by Conrad in his most recent catalogue of the *SOLENIDÆ*, published in Amer. Journ. of Conch., 1867, vol. III, pt. 3, Appendix p. 22, etc. The author quotes 126 recent species belonging to the family.

a. *Sub-family*,—*SOLENNINÆ*.

Shell very long, with the beaks at, or near, the anterior end, gaping at both ends; hinge with few teeth; ligament long, external on a thickened fulcrum, pallial line truncate, at first prolonged from the posterior muscular impression posteriorly in the direction of the longer diameter of the shell, and then moderately but broadly insinuated at the end. Siphons of the animals short, united or separated only at their terminations.

1. *Solen*, Linn., 1757. Shell straight, or nearly so, sub-cylindrical; beaks anterior, terminal or sub-terminal; hinge with one tooth in each valve; anterior muscular impression long, beginning below the beaks and extending parallel to the length of the shell; pallial impression anteriorly with an oblique projection. Several old authors, like Argenville, Klein, and others, used the name *Solen* correctly, but not in the pure generic sense, having generally added some other appellative to it; thus Klein writes *Solen bivalvis*. Of all the numerous species placed by Linné in the genus *Solen*, the name was reserved only for *S. vagina*, which is the type.

True species of *Solen* seem to occur already in palæozoic rocks, but none of the species, as, for instance, *Solen costatus*, Sandberger, and others have yet been found perfectly well preserved.

1a. *Solena*, Browne, 1756. (*Hypogella*, Gray, ? *Plectosolen*, Conrad, 1866). This name is used sub-generically for the designation of a section of *Solen*, (*obliquus*, *vaginatus*, &c.) which have the beaks sub-anterior, and the anterior muscular impression rounded.

The distinction can hardly be considered as of much importance, inasmuch as there are true *Solens*, which also have the anterior end somewhat produced. Deshayes' figures represent several such species from the eocene of the Paris basin (Paris Fossils, II ed., vol. I, pl. VII,) which, as far as form is concerned, belong to *Solena*, but they all seem to possess the anterior muscular scar, elongated, horizontal, as in typical recent species of *Solen*.

1b. *Plectosolen*. Conrad (Am. Journ. Conch., II, 1866, p. 103,) proposes this name to include a certain number of eocene species (like *S. gracilis*, Sow., *Sol. angustus*, Des.), which he says are either straight or slightly curved; the beaks are nearly terminal, and an anterior furrow extends direct or oblique from them to the lower margin, with a corresponding ridge within. This anterior ridge or rather internal depression corresponds to the sharpened edge of the foot when this is contracted and then assumes a clavate shape; it is the same as in typical *Solen*. The genus* seems to me to have been proposed merely with the object of suiting Mr. Conrad's idea, that every period which geologists call a formation was peopled by a distinct fauna.

2. *Ensis*, Schuhm., 1817. Shell slightly curved, beaks sub-terminal, hinge with one tooth in the right and two teeth† in the left valve, and a short ridge

* Mr. Conrad appears to have since abandoned the name *Plectosolen*, having found it to be based on untenable characters (see Pal., Calif., II, p. 176).

† H. and A. Adams, Gen., II, p. 342, state that the hinge is composed of two teeth in one, and three in the other valve: this must be a typographical error, as their figure evidently shows the contrary.

running posteriorly; anterior muscular impression very elongated, running from the beaks posteriorly in an oblique direction, pallial line anteriorly truncate.

The forms of *Ensis* are not as yet known from mesozoic formations.

3. *Solenopsis*, M'Coy, 1844, (Carb. Foss. of Ireland, ed. 1862, p. 47). Shell like *Solen*, but somewhat thicker anteriorly and with inflated beaks; posterior end truncate. This genus has been proposed for the reception of some palæozoic species, formerly described as *Solen*, like *S. pelagicus* and *vetustus* of Goldfuss, *S. siliquoides*, Kon., and others. The general form of these shells is very much like that of elongated species of *Sphenia*; the hinge-teeth, if any, are not as yet known, and it is therefore, strictly speaking, impossible to classify the genus correctly; d'Orbigny identifies it with *Lyonsia*.

4. *Solenaria*, Stoliczka, 1870. Shell thin, narrow, long and straight, like a *Solen*, internally with two radiating diverging ribs, originating at the beaks and proceeding towards the ventral edge. I propose this genus for *Leguminaria affinis*, Eichwald (Leth. Ross., XI, 1867, p. 788, pl. xxvi, fig. 12,) from the Turonian beds of Russia. The hinge is as yet not known, but the general form of the shell entirely agrees with *Solen*.

5. *Cultellus*, Schumacher, 1817. Shell compressed, ovate, slightly curved, gaping at both ends; anterior muscular impression rounded, posterior angular, pallial sinus small; hinge, according to Deshayes (Paris Fossils, II edit., 1864, p. 155,) with two teeth in the right, and one or two in the left valve. Schumacher and subsequent authors indicate three teeth in the right valve, but Deshayes says that he never found more than two. Possibly one is very small and occasionally obsolete, but if it actually ever exists the genus stands very close to *Ensis*, differing from it by the form of the anterior adductor muscle, the greater height of the shell in proportion to its length and the short rib below the beaks. There are no species known to occur in rocks older than the eocene with reliable certainty.

5a. *Ensiculus*, H. and A. Adams, 1860, (Proc. Zool. Soc., p. 369), has been proposed for the old *Solen Cultellus*, Lin., differing from the other species of *Cultellus* by its more elongated, curved, and parallel form, and the short oblique ribs below the umbones.

6. *Siliqua*, Mühlfeld, 1811. Shell compressed, straight, or slightly curved, thin, covered with a polished epidermis; beaks supported by an oblique strong rib, right valve with two, left with three teeth in the hinge; in the former they are usually distant, and occasionally there appears a third one between both; pallial sinus broad and deep.

Types of shells very similar to the recent *Siliquæ* already occur in palæozoic rocks, but as their hinge-teeth and pallial sinus are not known, it is impossible to distinguish them from *Solemyæ*. Somewhat better characterized are the forms of *Siliqua* in jurassic and cretaceous deposits, and their number gradually increases up to the present date.

b. *Sub-family*,—*PHARELLINÆ*.

The animals of this sub-division have the siphons generally separated, sometimes of very great length, the foot is clavate; the shells are thin, more or less ovate, and the hinge provided with numerous long teeth, which, however, often become obsolete with age. The genera here included are more numerous than those in the previous sub-family; they are, as already stated, mostly brackish water forms.

7. *Ceratisolen*, Forbes, 1848, (*Pharus* apud H. and A. Adams, Gen., II, p. 343; *Polia*, d'Orb). Valves thin, hinge with a radiating rib below; in the right valve with three teeth, the posterior very small, the central broadly bifurcate; in the left valve with two distant teeth, the smaller one near the ligament.

It is, I believe, quite correct, that the name *Pharus* be replaced by another one, inasmuch as the former has been already used in another branch of descriptive Natural History. Hörnes in his admirable work on the *Bivalves* of the Vienna basin introduces d'Orbigny's name *Polia*, but this name is no doubt also objectionable, not only because it is very easily mistaken for *Polia*, Gray, (a genus of the *MURICIDÆ*), but Gray himself occasionally writes the Gastropod name also *Polia*, (see index to vol. IV of Mrs. Gray's figures of Mollusca, p. 216). There are only two recent species known, *C. legumen*, Linn., and *C. scalprum*, Gould, of which the former also occurs in miocene deposits at several localities in Central and Southern Europe.

8. *Pharella*, Gray, 1854. Hinge with two teeth in the right and three in the left valve, the middle one in the latter bifid, all very thin, laterally compressed and close together; posterior muscular impression more or less elongated, placed nearly horizontally close to the upper edge, pallial sinus small.

Conrad in his above quoted catalogue refers four recent species to this genus. There were lately several fossil species also described, but the dentition of the hinges has not been pointed out. The hinge-teeth are indeed so very thin and fragile, that it is difficult to observe them even in recent shells, unless they have been taken alive. I shall subsequently mention the cretaceous species referable to this genus.

9. *Legumen*, Conrad, 1858, (Jour. Acad. Nat. Sc., Phil., 2nd ser., vol. III, p. 325). Valve very inequilateral; hinge with two very slender teeth in the right valve under the beak and one posterior very oblique prominent lamelliform tooth. This genus was proposed for a cretaceous species; the form of the teeth and their position agrees with *Novaculina*, but the posterior tooth is not lamelliform in this genus. A character of further importance is stated to be the shortness of the posterior part of the shell, which I have not seen in any of the European or Indian cretaceous species; it does, however, occur in some of the recent American species of *Tagelus*, from which *Legumen* would differ by its dentition, but externally it would seem impossible to distinguish between both of them.

10. *Leptosolen*, Conrad, 1867, (Am. Journ. Conch., iii, p. 15). "Elongated, thin in substance, straight, with the dorsal and ventral margins parallel; plicated

anteriorly, open at both ends; beaks not nearly terminal; hinge of the right valve with one direct tooth, convex anteriorly, truncated behind; an internal rounded direct rib commences under the cardinal margin, gradually becomes less prominent and disappears towards the ventral margin." This genus was proposed for the cretaceous *Siliqua biplicata*, Con. If the existence of a single tooth in the right valve can be considered as a permanent distinctive character, the separation from *Siliqua* would have good grounds. The tooth is said to be broadest at the hinge plate, and tapers to a very acute edge, which is expanded in the direction of the shell's diameter, (Am. Journ. Conch., iii, p. 188). This peculiarity in the form of the principal or cardinal tooth is often seen in species of *Tagelus*. Externally the type species resembles the recent *Pharella Javanica*.

11. *Mesopleura*, Con., 1867. Conrad in his catalogue of the *SOLENIDÆ* (Am. Journ. Conch., vol. iii, pt. 3, 1867), places under this newly suggested name *Solen bidentatus*, Spengler, *Sol. javanicus*, Lam., and *Cult. subteres*, Conrad. The last is left doubtful, but from the figure given of it in vol. vii of the Journal Acad. N. Sc., Phil., (pl. 17, fig. 10), its dentition would appear very similar to that of *Solecurtus*. The description of the dentition of *Sol. javanicus* given by Lamarck agrees with that of a *Pharella*. I possess a species from the Sundarbans, south-east of Calcutta, which is very much like *Sol. javanicus*, and most probably identical with it; I found the same also very plentifully about *Penang* in brackish water. This species is, however, in its dentition, pallial sinus, &c., a true *Pharella*. The third species, *S. bidentatus*, I am unable to make out satisfactorily from Chemnitz' figure in the new edition of his work. If it be, however, identical with Say's *Solen centralis*, described in Journal Ac. Nat. Sc., Phil., vol. ii, p. 316, and if this species is to be considered as the type of this genus, proposed under the name of *Mesopleura*, it will only differ from *Solecurtus* by a short internal rib issuing below the beaks, proceeding obliquely and posteriorly towards the ventral edge. It would thus form a connecting link between *Ceratisolen* and *Solecurtus*, though very closely allied to the latter.

p. 481 12. *Solecurtus*, Blainv., 1825, (*Psammosolen*, Risso, 1826; *Macha*, Oken, 1835, not 1815). Shell transversally elongated, the beaks are generally sub-central, the ligamental fulcrum is large, anterior muscular impression elongated, pear-shaped, posterior sub-quadrangular or roundish, pallial sinus deep, hinge with two approximate teeth in the right valve, and two somewhat more distant in the left; of the latter the posterior one at the beginning of the fulcrum is sometimes obsolete.

Forms which in their external appearance fully agree with recent species of *Solecurtus* are abundantly known from the palæozoic rocks, but they only become sufficiently recognized from the jurassic epoch upwards. Several of the upper tertiary species, like *S. strigilatus*, &c., are the same as the recent ones.

13. *Azor*, Gray, 1847, has been suggested for the recent *Sol. coarctatus* on account of its smooth epidermis. The distinction is scarcely more than a sub-generic one. But if all the forms possess the above character and have two teeth in the

right and only one in the left valve, they could form the basis of a generic distinction. Dunker (Proc. Zool. Soc., 1861, p. 425,) describes several new species of *Azor*.

14. *Cleidophorus*, Hall, 1850, (Pal. New York, ii, p. 300), has been proposed for a palæozoic form, which in external character resembles *Solecurtus* and *Azor*, but nothing is known of the hinge.

15. *Tagelus*, Gray, 1847, (*Siliquaria*, Schuhmacher, 1817, non *Siliquarius*, alias *Siliquaria*, Montf., 1810). Shell, like *Solecurtus*, elongated, with the beaks nearly central, directed backwards, pallial sinus very deep, reaching anteriorly usually beyond the beaks; two teeth in the right and two in the left valve, the posterior one in the latter often obsolete, fulcrum supporting a long and strong ligament; surface covered with a concentrically striated, often rough olivaceous epidermis.

These shells chiefly inhabit the mouths of rivers of the new world; they have the general character of brackish shells. The animals, so far as they have been examined, have long cylindrical siphons united at the base.

16. *Novaculina*, Benson, 1830. Shell transversally elongated, covered with a striated, more or less rough epidermis, beaks sub-anterior, regularly incurved, hinge in the left valve with three diverging teeth, the middle of which is the smallest; in the right with two teeth, the anterior usually obsoletely bifid, the posterior very oblique; pallial sinus deep, but not extending anteriorly beyond the region of the beaks; ligament strong, fulcrum not prominent and rather short. The *Novaculinæ* inhabit tidal rivers of the eastern hemisphere; they are the representants of the American *Tagelus*, but appear to be quite distinct. The siphons of the animal are very long, cylindrical, and separated from the base, the foot is, however, club-shaped.

Rafinesque appears to have applied to a worn specimen of a *Novaculina* the generic name *Loncosilla*. He states that the hinge has "no teeth as in *Anodonta*, but a hinge with a marginal nerve, or fold anteriorly, distinct from the margin and a little oblique behind," (see complete writings of C. S. Rafinesque on rec. and foss. Conchology, by Binney and Tryon, 1864, p. 84). The hinge-teeth of *Novaculina*, like those of *Pharella*, are very easily broken away, and there is often no trace of them perceptible in apparently perfectly well preserved specimens. *Novaculina* has a distinct margin at the hinge and a slight groove extending anteriorly; it appears therefore very probable that Rafinesque's *Loncosilla solenoides* was an old worn specimen of *Novaculina gangetica*.

Two such genera, as *Novaculina* and *Tagelus*, form, not only in the arrangement of the diverging hinge-teeth, but also through the deep pallial sinus, the long and divided siphons of the animals, and their mode of living, a distinct passage to *Sanguinolaria*, *Soletellina*, and other typical genera of the next family.

SPECIES OF *SOLENIIDÆ* FROM CRETACEOUS ROCKS.

Regarding the correct generic determination of most of the cretaceous species, only a few suggestions can be made. (See Pictet and Campiche, Pal. Suisse, 4^{me} ser., 1864, p. 29, etc.).

1.—*Solen Dupinianus*, d'Orb., known only by a fragment perfectly insufficient for determination.

2.—*S. Carentonensis*, Coq., is not sufficiently characterized, but judging from the short description given of it, it is likely to be a small, compressed specimen of a *Siliqua* or of a *Pharella*.

3.—*S. ? clavæformis*, Gümbel; the description is quite insufficient on which to form an opinion as to the true characters of the shell.

4.—*Solec. Robinaldinus*, d'Orb.; the form of the shell and that of the muscular impression entirely agree with those of a *Tagelus*.

5.—*Solec. Warburtoni*, Forb., has entirely the form of a *Ceratisolen*. The radiating striæ, however, recall the ornamentation of some of the species of *TELLINIDÆ*, and I do not know any species of recent *SOLENIIDÆ* in which they occur.

6.—*Solec. Desori*, Pict. and Renev.; only known by a half of the right valve, the beaks appear to be incurved toward the ligament, as in *Tagelus*.

7.—*Solec. æqualis*, d'Orb., resembles somewhat a *Pharella*, but it may equally probably be a species of the *TELLINIDÆ*. Reuss (Böhm. Kreid. II, p. 16, pl. xxxvi, fig. 6,) describes from Bohemia a similar species which he identifies with d'Orbigny's *S. æqualis*, but it has the beak still more central than this last, and may still more likely be a *Tellinide*. Müller quotes *S. æqualis*, d'Orb., from the Senonien of Aachen, (Monog. Pet. Aach. Kreide., 1847, p. 28); but Bosquet in his catalogue of the fossil flora and fauna from Limburg (Staring's Bodem van Nederland, ii deel,) seems to doubt the identity of the species, referred to by Müller, with that of d'Orbigny. A correct examination of all the species or specimens which have been called *Solen æqualis* would be most desirable and absolutely necessary for the purpose of clearing away the existing uncertainty of determination.

8.—*Sol. Guerangeri*, d'Orb., belongs apparently to *Pharella*, or possibly to *Azor*. *Panopæa sinuata*, Reuss, is much of the same type.

9.—*Sol. pelagi*, d'Orb., (Guéranger, Album Paléont. de la Sarthe, 1867, pl. xv, fig. 6,) is of the same type as the former.

10.—*Sol. Acteon*, d'Orb., (Guéranger, loc. cit., figs. 1-2), is probably a true *Solecurtus*.

11.—*Sol. radians*, d'Orb., (= *elegans*, d'Orb., non id. Matheron, Guéranger, loc. cit., fig. 5,) is more probably a *Gari* (*Psammobia*), on account of the radiating lines.

12.—*Solen elegans*, Math., is also more likely a *Tellinide* than a species of the *SOLENIIDÆ*.

13.—*Sol. carinatus*, Math., (Cat. Méth., &c., 1842, pl. xi, figs. 1-2,) which was transferred by d'Orbigny to the genus *Anatina*, has entirely the form of a *Ceratisolen*, except that the cast does not show a rib under the beaks.

14.—*Solen inflexus*, Duj., appears to be very closely allied to *Sol. Guerangeri*.

15.—*Solen compressus*, Goldf., (Pet. Germ., p. 276, pl. 159, fig. 4 = *Sol. sub-compressus*,* d'Orb., non *Solec. compressus*, Sow.). Goldfuss' figure of this species represents a form which in general shape, position and form of the muscular impressions, and the thin structure of the shell, agrees with some recent species of *Siliqua*, such as *S. radiata*. No mention is made of the existence of a rib below the beaks, but there seems to be an indication of it just behind the anterior muscular impression. If this, however, merely represents an accidental break in the cast, the species could only be referred to *Pharella*. Müller's statement (Monog. Pet. Aach. Kreidef., 1847, p. 28,) is not intelligible. For though he appears to regard Goldfuss' figure as correct, he says that the beaks are placed so far posteriorly, that the anterior portion of the valves is double as long as the posterior one; the reverse appears, however, to be shown in Goldfuss' figure. Subsequent authors do not mention anything about this discrepancy. Should, therefore, the species not be a *Siliqua*,

* This change of the specific names is entirely uncalled for, because the generic determination of *Sanguinolaria compressa*, Sow., or of *Solen compressus*, Goldf., both of which d'Orbigny refers to *Solecurtus*, neither is, nor can, according to the existing materials, be satisfactorily settled.

and should Goldfuss' figure, as I explain it, not prove correct, we must probably search after the relations of this species in the genus *Legumen*, which I have previously noticed (p. 96).

16.—*Solen Petschoræ*, Keys., (Eichwald, Leth. Ross. xi livr., 1867, p. 787,) has the general form of a *Pharella*, and occurs in beds which are supposed to be of Neocomien age.

Mr. Eichwald also supposes that the beds on the Aral Sea, from which Abich quotes a species under the name of *Solec. Lamarekii* (= *Solec. Deshayesii*, Des-Moul.), belong to the cretaceous period.

Zittel (Denksh. Akad., Wien, vol. xxiv, pt. 2, p. 110,) mentions from the Gosau deposits an undetermined species of a *Solecurtus*.

17.—*Siliqua Moreana*, d'Orb., only known by half the length of both valves; appears to be remarkably straight in form.

18.—*Sil. Nereis*, d'Orb., merely known by a very short note.

19.—*Sil. truncatula*, Rss., from the Senonian beds of Bohemia.

20.—*Sil. Petersi*, Rss., (Denksh. Akad., Wien, 1865, vol. xxiv, pt. ii, p. 109, pl. i, fig. 3,) is from the beds of the Alpine Gosau formation.

21.—*Solenaria affinis*, Eichw. sp., (see p. 95). Eichwald (l. cit.) says that this species is probably allied to "*Legumin. Schuhmacheri*, Reuss," the name of which is unknown to me. The same author (loc. cit., p. 289), notices a fragment of a somewhat allied, but much smaller species.

22-27.—The following species are recorded by Meek in his Check list of North Am. cretaceous fossils (Smiths. Mis. Coll., No. 177, p. 15): *Siliqua biplicata*, Conr., and *S. cretacea*, Gabb; *Pharella dakotensis*, Meek and Hayd.; *Legumen appressa*, Con., *Leg. elliptica*, Conr., and *Leg. planata*, Gabb. For the first of these species Conrad proposed the generic name *Leptosolen*, as already mentioned (see p. 96).

28.—Römer describes from Texas *Sol. irradians*, which may with equal probability be a *Gari* (*Psammobia*), or a *Trapezium*.

29.—*Siliq. australis*, Gabb, at first described under the name of *Cultellus*, has the general form of this genus, but is a higher shell. The species is from Chili.

30-32.—Gabb describes in the Palæontology of California, vol. i, p. 146, &c., *Solen parallelus*, *Pharella alta* and *Siliqua oregonensis*; the last species has quite the form of a *Solemya*, regarding the position of the internal umbonal rib.

33-34.—Another species, *S. Diegonensis*, is referred by the same author to the sub-genus *Solena* (ibid. p. 213, pl. xxxii, fig. 280). More recently (ibid. vol. ii, p. 176,) Gabb adopts for the species the sub-generic name *Hypogella*, pronouncing this apparently to be identical with Conrad's *Plectosolen*. The same author also describes another species *S. (Hypog.) cuneatus* from California.

35-38.—Four species occur in the South Indian cretaceous deposits, *Siliqua limata*, *Pharella delicatula*, *Solecurtus obscurus*, and *Tagelus Albertinus*.

The *Tellina angulata* and *Pandora æquivalvis* of Deshayes both probably come near *Pharella*; the former is, as regards external shape, not to be distinguished from some species of *Azor*.

Thus out of a number of 37 species recorded under the family *SOLENIDÆ* there are about 32 which, at least to a certain extent, admit of an approximate generic determination. Of these there are only two species which possibly belong to the *SOLENINÆ*, namely, the somewhat doubtful *Solen parallelus*, Gabb, from America and the remarkable *Solenaria affinis*, Eichw., from Russia. All the other species, and some more which on account of insufficient preservation have not yet received specific names, belong to the *PHARELLINÆ*. Out of these again most of the species externally appear to resemble forms like *Azor*, *Pharella*, *Tagelus*, and others are fairly distinguishable as *Siliqua*. However, until the hinges, the pallial and the muscular impressions of the various species are known, it would be in vain to expect a final settlement of the numerous objections which at present can be made against the generic classification of the cretaceous forms.

SILIQUA, *Meg. v. Mühlfeld*, 1811 (see p. 95).

✓ 1. SILIQUA LIMATA, *Stoliczka*, Pl. I, Figs. 12-13.

Sil. testa valvis elongatis, sub-convexis, valde inæquilateralibus, antice ac postice subrotundatis atque angustatis, tenuibus, politis, concentricè minute striatis, utraque intus sub-umbone costa crassiuscula oblique postice versus fere ad marginem ventralem decurrente instructa.

Height of shell : its length 0.32

This species is closely allied to *S. Petersi*, Reuss, from the Alpine Gosau formation, but is narrower in proportion to its length and the valves are perceptibly more convex. The posterior end of the valves is extremely thin and breaks off very easily, in which case the shell appears to be rather more truncate than it is naturally. The rib under the umbones is very strong as compared with the size of the shell. Of the hinge only indistinct impressions are traceable, the teeth themselves must have been very minute.

Locality.—South-east of Parchairy and Garudamungalum; at both localities in a compact highly calcareous brownish or bluish sandstone, in company with a very large number of small shells.

Formation.—Trichinopoly group.

PHARELLA, *Gray*, 1854, (see p. 96).

✓ 1. PHARELLA DELICATULA, *Stoliczka*, Pl. I, Fig. 14.

Ph. testa elongata, angusta, tenuissima, valde inæquilaterali, antice sub-rotundata, postice oblique truncata, margine dorsali ac ventrali fere parallelis, umbonibus paulo prominulis, linea elevata ab umbonibus oblique postice ac antice decurrente, prima distincta, altera fere obsoleta; superficie lineis concentricis minutis notata; impressione musculari antica pyriformi, postica angustata ac elongata.

Height of one valve : its length 0.26

This is a remarkably thin shell; in form and the shape of the muscular impressions it agrees with a narrow species of *Pharella*. The pallial sinus appears to have been very short, but is not clearly traceable on any of our specimens; neither was it possible to observe the hinge-teeth.

Locality.—South-east of Parchairy.

Formation.—Trichinopoly group.

✓ 2. PHARELLA OBSCURA, *Forb., sp.*, Pl. I, Fig. 15.

1846. *Solecurtus obscurus*, Forbes, Trans., Geol. Soc., London, vii, p. 141, pl. xvii, fig. 3—*idem* auctorum.

Ph. testa elongata, valde inæquilaterali, umbonibus prominulis, acutis, eorumque margine ventrali opposito lente insinuato instructa, antice rotundata, postice oblique truncata; superficie striis concentricis, crassioribus et tenuioribus ornata; impressione musculari antica atque postica pyriformi, prima breviori, altera elongata; sinu pallii brevi.

Height of shell : its length 0.30

The compressed, elongated, and rather high shell, ornamented with coarsely lamellar concentric striæ, is very characteristic for this species. It has been

described as *Solecurtus* by Forbes, but the form of the muscular impressions and the very short pallial sinus make it much more probable that it belongs to *Pharella*. One of our specimens shows the hinge line below the beaks preserved, but there are no teeth perceptible on it, which must have been broken off before the specimen was buried in the rock, as is of common occurrence in recent species of *Pharella*. In shape our species recalls d'Orbigny's *Sol. Guerangeri*.

Locality.—Pondicherry, in a brownish, grey, compact, highly calcareous sandstone.

Formation.—Valudayur group (?).

TAGELUS, Gray, 1847, (see p. 98).

✓ TAGELUS ALBERTINUS, d'Orbigny, Pl. IV, Fig. 3.

1847. *Tellina Albertina*, d'Orb., Pal. de la voy. Astrolabe, pl. 4, fig. 23.

Tag. valva sinistra elongata, fere æquilaterali, parte posteriori paulo longiori quam anteriori, superficie concentricè striata, in medio impressa atque ad marginem ventralem insinuata, antice rotundata; umbone prominente, postice versus incurvo, fulcro ligamenti longo ac crassulo, umbone duobus dentibus parvis distantibus instructo.

Height of the valve : its approximate length 0.37

Only the single figured left valve has been found. Its elongated form depressed in the middle, the distinct concentric striation, the great length of the fulcrum and the presence of two (though very small) teeth on a thickened margin of the hinge so entirely agree with the recent species of *Tagelus*, that I have no hesitation in placing our fossil in that genus. The recent *Tagelus* mostly are brackish water species; but although we have in South India not yet proved the existence of a large brackish fauna, the occurrence of *HELICIDÆ* in marine beds at Comarapolliam sufficiently indicate that land was not far off, and if this were the case the want of rivers would also be extremely improbable. Our species has a close ally in d'Orbigny's *Solec. (Tagelus) Robinaldinus*, which is only somewhat more elongated in proportion to its height.

D'Orbigny's figure of *Tellina Albertina* is in proportion a little higher, but there can be no doubt that it represents the same species as ours.

Locality.—Comarapolliam, in a soft, whitish sandstone.

Formation.—Arrialoor group.

III. Order. **TELLINACEA.**

(TELLINIDÆ apud H. and A. Adams).

Looking at the large number of the so-called *Tellina*-group of shells there are some distinctive peculiarities traceable which entitle them to be classed as a separate order of the Pelecypoda. The animals all possess entirely divided siphons of great length, the mantle is only partially united below and widely open in front, the foot large, compressed, and lingui-form at the end; the palpi are large and triangular, usually coarsely striated; the gills narrow, long, partially united posteriorly above the siphons; the two leaflets composing the gills on either side of the body are generally unequal, and one of them is sometimes nearly obsolete. The shells of the **TELLINACEA** are always considered as particularly elegant in form and ornamentation; they are usually strongly compressed, thin or solid, transversally more or less elongated, posteriorly generally flexuous, a more or less distinct ridge, or plicature, running from the beaks along the postero-superior margin to the posterior end. The surface is usually ornamented with very regular concentric striæ or ribs, and if any other ornamentation appears, it always shows a great regularity, and this character especially is it which gives the shells their elegant appearance. The hinge is, as a rule, composed of two cardinal teeth in each valve, occasionally one of them in one or the other valve becomes obsolete, but very rarely is there an additional cardinal tooth in one valve; lateral teeth are often present. The pallial sinus is with few exceptions large; the ligament is generally strong and distinct, rarely nearly obsolete; a cartilage appears occasionally, but does not form one of the essential characters of the shells. H. and A. Adams have classed the whole of this order in one family, *TELLINIDÆ*, but there can be little doubt that the peculiarities which many of the shells exhibit make it very desirable to distinguish several families, as has been many years ago suggested by Deshayes. Only when such divisions are fairly established will it be possible to make a proper comparison between the various forms of the **TELLINACEA** and the **VENERACEA**.

With regard to this point of classification two principal divisions, or tribes, can first be traced out: some with an internal cartilage and others without it. To the former belong the *PAPHIIDÆ* (= *MESODESMIDÆ*) and *SCROBICULARIIDÆ* (= *AMPHIDESMIDÆ*); to the latter the *TELLINIDÆ* and *DONACIDÆ*. The reason for uniting Deshayes' *TELLINIDÆ* and *PSAMMOBIIDÆ* (= *GARINÆ*) will be detailed subsequently. Among these four families, as here accepted, the *PAPHIIDÆ* and *DONACIDÆ* on the one side and the *SCROBICULARIIDÆ* and *TELLINIDÆ* on the other may be said to form parallel divisions; each two, respectively, exhibiting in form and in the solid or thin structure of their shells very marked relations. As the shells with an internal ligament are often considered to be more highly organised than those without it, I shall begin with the family *PAPHIIDÆ*, especially also because they very much recall some of the characters of the *MACTRIDÆ*, though, as already stated, the *GARINÆ* and other *TELLINIDÆ* offer the greatest resemblance to the *PHARELLINÆ* of the *SOLENIIDÆ*.

The recent species of the *TELLINACEA* of which Tryon lately published a catalogue in pt. 5 of vol. iv, Am. Journ. Conch., 1868, are to by far the greatest extent inhabitants of moderate depths of the sea and of sandy shores; only very few burrow in corals, in which cases some modifications in the form of the foot are to be observed. With respect to geological age we have no sufficient proof of their existence in palæozoic times; they are scarce in the lower and not common in the upper mesozoic epoch; in the caenozoic epoch, however, their number increases considerably, but hardly equals half of what it is at the present time.

A. *TELLINACEA* with a cartilage in the hinge.

IX. *Family*,—*PAPHIIDÆ*.

(*MESODESMIDÆ*, olim Gray, Desh., Sandberger, Høernes, &c.).

The animals, as far as they have been examined, are typical *TELLINACEA*, inasmuch as the siphons, though short and thick, are separated from their bases, the foot is lingui-form, laterally compressed; the palpi are, however, rather short and the two gills on each side unequal; the mantle is widely open only in front and narrowly behind; the united portion below the siphons is considerably larger than in true *TELLINIDÆ*.

Shell solid, sub-trigonal, or transversally oblong, closed all round, equivalve, generally inequilateral, the posterior side being often the shorter one; hinge with an internal cartilage-pit and usually with one cardinal tooth on each side of it; lateral teeth variable, present either on both sides or only on one, or entirely obsolete; ligament externally above the cartilage-pit either distinct, though always very thin, or only indicated by a thickening of the epidermis which covers the shell; muscular impressions strong; pallial line generally with a small posterior sinus, occasionally entire.

It is more the combination of certain characters which distinguish this family, than their peculiarities as regards other allied forms. The animals a great deal resemble those of *Donax*, and the shell is in external shape equally often very similar in both, while the presence of a cartilage places them next to the *SCROBICULARIIDÆ*, from which, however, the animal and shells greatly differ.

The family was first instituted by Dr. Gray under the name *MESODESMIDÆ*, but was subsequently by the same author replaced by that of *PAPHIIDÆ* (or *PAPHIADÆ*). I consider this substitution as one thoroughly in accordance with the laws of priority, and by no means undesirable (as Deshayes says) on account of the subsequent introduction of the name *Mesodesma* into conchological literature.*

* Mr. Deshayes states that Lamarck described two different generic forms under the name of *Paphia*, and that Lamarck had himself given up the latter name. One of the two species is a *Crassatella*, proposed on the previous page of the same work, to which genus, Deshayes admits, the species must be referred; for the other, the name *Paphia* must, in my opinion, be retained, but not replaced by a new one, as suggested by Deshayes; for if that plan was to be adopted, it would necessarily follow that the name *Crassatella* must be struck off the list also, as there equally was a mixture of species in it similar to that of the present genus. Lamarck had, as I have already pointed out, no more right to change or abandon any of his names introduced into science, than any one else had.

I have already alluded to the great similarity and relation between the shells of the *PAPHIIDÆ* and those of the *LUTRARINÆ*, a relation pointed out long ago by Deshayes. The internal cartilage and the lateral teeth of many forms are no doubt closely allied to those of *Darinia* and *Cæcella*, but the peculiar short \wedge -form tooth in front of the cartilage-pit, so characteristic for all *MACTRIDÆ*, is never present in the *PAPHIIDÆ*, although one of the cardinal teeth, the posterior, in the right valve is generally shorter and more prominent than the other. The smallness of the pallial sinus, or its entire absence, also reminds one of the genera *Cæcella* and *Anatinella*.

Gray first referred three genera to the family—*Paphia*, *Anapa*, and *Ervilia*; all three are now admitted by Deshayes in his 2nd edit. of the Paris fossils as good genera. H. and A. Adams have, I think, in this case carried the generic division too far; it is, to say the least, impossible for any one not having the types of the various generic divisions before him to understand what their real characteristics should be. I shall here retain some of H. and A. Adams' genera only as sub-genera.

1. *Ervilia*, Turton, 1822. Transversally oblong, moderately solid, hinge with two cardinal teeth in each valve, and in the left valve of some species with a small additional anterior tooth situated quite close to the lunular margin; pallial sinus distinct.

2. *Anapa*, Gray, 1840. Shell sub-trigonal, ventricose, truncated behind; lateral teeth sub-equal, compressed, smooth; pallial line entire; type *A. cuneata*, Desh.; most of the species are from New Zealand.

2a. The Phillippine species of a more oval or rounded and compressed form, like *A. crassula*, Desh., were named by Gray *Davila*, which ought to stand only as a sub-genus of *Anapa*.

I may notice here the similarity of the shells of *Anapa* and *Gnathodon*, and it is possible, when the animals of more species have been examined, that both genera may be classed in the same family. It is also worth mentioning the remarkable relation of some of the shells of *Crassatella* to those of *Anapa*.

3. *Paphia*, Lam., 1799, (*Mesodesma*, Desh., 1830). Shell sub-trigonal, transversally oval, sub-equilateral, or with the posterior part a little shorter, central teeth simple, partially very small, lateral teeth more or less prolonged, the anterior generally shorter than the posterior, pallial sinus small, angular.

H. and A. Adams separate *Taria* as a sub-genus of *Paphia*, and consider Deshayes' *Mesodesma* (including *M. mactroides*, Desh. and oth.) and Lamarck's *Donacilla* (with the type species *D. cornea*, Poli.) as genera, but I do not think there is sufficient distinction in the character of those shells to justify that separation. Some of the oblong forms of these so-called *Mesodesma* and *Donacilla* could perhaps, for sake of convenience, be grouped in a special section, but it is impossible to characterize the shells so as readily to distinguish them from those referred to *Paphia* proper.

3a. The species, like *Paph. Tauresii* and others, called *Ceronia* by Gray, combine with an elongately oval form the crenulations of the lateral teeth, and may on this account be regarded as a sub-genus or section, but not as a distinct genus.

4. *Mactropsis*, Conrad, 186?; (see Am. Journ. Conch., 1865, I, p. 3). In the Check list of eocene fossils (1866, p. 7,) Conrad places the genus in this family. Judging from the figure of one of the species, *Mactra Grayii*, Lea, (Cont. to Geol., pl. I, fig. 10 = *M. æquorea*, Conr.), the shell resembles in form *Anapa*; it has in the left valve either one bifid or two diverging cardinal teeth, a distinct anterior, but less prominent posterior lateral tooth; it is said to possess a small obtusely angular pallial sinus; in external appearance it looks very much like a *Crassatella*.

In the present seas about 45 species of *PAPHIIDÆ* have been observed. Fossil species are always great rarities; only a small number is known from the tertiaries, but none from cretaceous, or older deposits; at least none of the older so called *Mesodesmæ* have as yet been satisfactorily proved to belong to *Paphia*. It is, therefore, not necessary to occupy ourselves for the present with this family any further.

X. Family,—SCROBICULARIIDÆ.

In this family the animals usually have a prolonged strongly compressed and pointed, but not a high foot; the palpi are very large, sub-triangular, striated, the gills, of which two exist on each side, being smaller than the palpi; the two siphons are very long, unequal, thin, at their terminations mostly entire, the mantle is for a very short distance united at the posterior ventral side, open, as usually, in front and behind.

The shells are sub-triangular, or more or less roundish, usually thin, equivalve, slightly gaping posteriorly; external ligament thin, but generally distinct; hinge with a cartilage-pit, situated either almost parallel to the areal margin, or in a projecting process; generally one or two small cardinal teeth in front of the pit; lateral teeth present or obsolete; pallial sinus large.

When Deshayes first characterized this family (Traité elem. de Conch., p. 317,) under Lattreille's name *AMPHIDESMIDÆ*, he placed in it four genera, *Cumingia*, *Semele* (= *Amphidesma*), *Syndosmya* (= *Abra*), and *Scrobicularia* (= *Lavignon* or *Trigonella*); to these *Theora*, *Plectodon*, *Leptomya*, *Thyella*, *Montrouzieria*, the fossil genus *Palæomya*, and several sub-genera now have to be added. They may be divided into two groups, *CUMINGIINÆ* and *SEMELINÆ*. The first possess a solid shell with a special, more or less straight, or vertical cartilage process, and are transversally elongated, much resembling some forms of the *LUTRARIINÆ*; to this division *Cumingia*, *Thyella*, and *Montrouzieria* belong. The others have a thinner shell and a simple, posteriorly prolonged oblique cartilage-pit or groove; to this group the remaining genera with a few sub-genera are referable; they form a good passage to the *TELLINIDÆ*.

The *SCROBICULARIIDÆ* are principally characterized by the great length and thinness of the siphons and a comparatively thin shell with an internal straight or oblique and posteriorly directed cartilage-pit. There is a remarkable similarity in all the shells which entitles their forming a special group, distinct from the *Tellens*. This separation is also justified by geological research. There are as yet no thoroughly reliable proofs of any species of this family occurring in mesozoic rocks, though some cretaceous species seem to be strongly indicated; those from tertiary deposits are not very numerous.* Of recent species there are about 120 species† known, and of these certainly one-half belongs to the genus *Semele*. The Indian seas contain representatives of most of the genera and a large number of species. Those of the *Cumingia* group are perhaps most imperfectly known, and many additions may, I believe, be expected from Indian seas.

a. *Sub-family*,—*CUMINGIINÆ*.

Most of the species of this sub-family burrow in corals and stones, like *Petricolæ*, and the concentric striae are therefore very sharp and prominent; the foot of the animals is generally very small.

1. *Cumingia*, Sow., 1833. Shell transversally elongated, gaping posteriorly; hinge with a projecting oblique cartilage process, in front of which there are usually two thin laminar cardinal teeth in the right, and one—occasionally bifid—in the left valve; one distinct lateral tooth on either side, both stronger in the right than in the left valve. The species of *Cumingia* are usually found burrowing in corals.

H. and A. Adams state that there are no lateral teeth in one valve. I have examined five species of *Cumingia* from the eastern seas, and all certainly had the laterals in the right valve stronger, but by no means obsolete in the left one. Deshayes describes the animal and shell of a *Cum. grandis*, which is remarkably elongated, posteriorly attenuated, very much like a *Syndosmya*, and also apparently of a much thinner structure; it could probably form a distinct section of the genus, for its habitat seems also to be different from that of other *Cumingiæ* (see Jour. de Conch., vol. v, 1856, p. 378, &c.).

2. *Montrouzieria*, Souv., 1863, (Journal de Conch., 3^{me} ser., vol. ii, p. 282). Shell moderately elongated, hinge with the cartilage in a posteriorly directed groove, two cardinal teeth in front of it in the right valve, a single triangular, bifid one in the left; posterior but quite close to the cartilage-pit there is in each valve one short lateral tooth, looking, however, more like a posterior cardinal. Souverbie's type species *M. clathrata* is from New Caledonia. I have also examined a new species which Mr. G. Nevill collected at Mauritius; it is similar in form to the last, having the posterior lateral (cardinal?) teeth very small, thin, and in the left valve almost obsolete; thus it very closely approaches in character to the next genus, which may perhaps be considered only as a peculiar section of the former.

* I have good reason to believe that Deshayes' number of species of *Syndosmya* from the Paris basin must be somewhat reduced.

† Tryon quotes in his catalogue 108 species.

3. *Thyella*, H. Ad., 1865, (Proc. Zool. Soc., Lond., p. 754). Shell rather inflated, sub-triangular, truncated posteriorly, surface desussated, striated; cartilage in an almost straight, projecting process; hinge in the right valve with two cardinal teeth, of which the anterior is bifid, in the left valve a single one bifid; no lateral teeth. *Th. pulchra* from Singapore is the only species as yet known.

b. Sub-family,—*SEMELINÆ*.

The species of this sub-division chiefly bury in sand, and have very long siphons.

4. *Semele*,* Schuhmacher, 1817, (*Amphidesma*, Lam., 1818, apud Deshayes and others). Shell oval, or sub-orbicular, hinge generally with two cardinal teeth in front of the narrow oblique cartilage groove, the anterior in the right and the posterior in the left valve are usually smaller and sometimes become almost obsolete; lateral teeth close to the cardinal, well developed, but generally smaller in the left valve; pallial sinus ascending, wide, rounded at its termination.

5. *Syndosmya*,† Recluz, 1843, (*Abra*, apud H. and A. Adams). Shell transversally elongated, more or less attenuated posteriorly, thin, sub-equilateral; hinge in the right valve with two small cardinal teeth, in the left with one; occasionally all become obsolete; lateral teeth usually distinct, but sometimes very small and almost obsolete.

The *Syndosmyæ* are much thinner and posteriorly much more attenuated shells, than species of *Semele*.

6. *Theora*, H. and A. Adams, 1854. Shell transversally elongated, more or less tumid, posteriorly attenuated, very thin, often hyaline, gaping posteriorly; hinge with two minute cardinal teeth in the right valve in front of an oblique posteriorly directed cartilage process, one cardinal tooth, usually bifid in the left valve; all the cardinals become obsolete in some species; lateral teeth distinct, anterior close to the cardinal and in the left valve almost obsolete; external ligament thin, but sometimes supported by distinct fulcra, which are tooth-like, more thickened inside than prominent above; pallial sinus deep.

The *Theoræ* live in mud and sometimes brackish water. I have examined the animal which has a strongly compressed, linguiform foot, and two perfectly separated long siphons, and thus fully confirms A. Adam's suggestion, that the genus belongs to the "*Scrobiculariate* division of the *TELLINIDÆ*."

* The name *Amphidesma* cannot be justly accepted in place of *Semele*. I may quote Philippi (Handb. der Conch., p. 312,) on the subject; he says: "The name *Semele* not only has priority before *Amphidesma*, but deserves to be accepted also for another reason, inasmuch as *Amphidesma* of Lamarck is a *mixtum compositum* of species of *Semele*, *Lucina*, *Donacilla*, *Abra*, *Thracia*, *Osteodesma*, *Kellia*, &c."

† In this case Recluz's name must, I think, have preference. It is true that Lamarck in 1818 quoted several times the name *Abra* under the synonyms of various species, but nobody knew, or could know, what *Abra* meant, and whether Lamarck intended retaining a genus called *Abra*, and only transferring some of its species to *Amphidesma*, or otherwise. *Abra* as a generic name had not been characterized, so far as I know, nor in any way restricted to a known type species before the introduction of Recluz's name, and has, therefore, no claim to priority.

6a. A. Adams considers the species of *Theora* to be without primary teeth, which certainly is not always the case. He consequently suggests for a peculiar Chinese form with a "primary tooth in front of the oblique cartilage-pit" and "with an internal rib extending from the beaks obliquely towards the anterior side" the name *Endopleura* as a sub-genus. The internal rib may be characteristic, but this is not the case as regards the presence of cardinal teeth, (see Ann. Mag. Nat. Hist., xiii, 1864, p. 209).

7. *Plectodon*, Carpt., 1866, (Proc. Calif. Acad. Nat. Sc., p. 207). This shell is said to be allied to *Neæra* and to have the aspect of a *Theora*. The shell is thin, not peculiarly inflated, the upper margin is twisted under the umbones, forming the cardinal tooth; lateral teeth long, lamellar; cartilage-pit under the umbones very small, almost quite hidden, situated next to the posterior lateral tooth; pallial sinus small. The species described is *P. scaber* from California; the presence of lateral teeth (though not sufficiently characterized) and the position of the cartilage-pit appear to indicate that the shell in question is more allied to *Theora* than to *Neæra* and its allies.

8. *Leptomya*, A. Ad., 1864, (Ann. Mag. Nat. Hist., xiii, p. 208). "Shell thin, ventricose, beaked posteriorly; surface of valves lamellar; hinge with an oblique cartilage-pit in each valve; right valve with two anterior primary teeth, left valve with a single primary tooth; lateral teeth none; pallial sinus deep." *Neæra cochlearis*, Hinds, and *Scrob. adunca*, Gould, are the two species referred by A. Adams to this genus.

8a. *Leiomya*, A. Ad., 1864, (ibid). Shell hyaline, hinge with two prominent lateral teeth; in other respects identical with *Leptomya*. *Neæra adunca*, Gould, is the type species.

9. *Palæomya*, Zitt. and Goub., 1861, (Jour. de Conch., vol. ix, p. 194). Shell in general form very much like some species of *Theora*, transversally elongated, posteriorly somewhat attenuated and longer, anteriorly sub-truncate; right valve with two cardinal teeth separated by a cartilage groove, which is lodged very close to the posterior one, one anterior cardinal tooth in the left valve; lateral teeth well developed, the posterior particularly long and the anterior rib-like.

The form of the shell, the oblique cartilage groove, and the lateral teeth clearly exhibit the great relation of this form to *Theora*, from which it only differs by the stronger anterior lateral tooth, being rib-like, and the posterior cardinal in the right valve, though the last seems to me to be identical with what I have mentioned in *Theora* as the thick fulcrum; it is in some species considerably thickened, especially in the right valve. The jurassic *Pal. Deshayesi* is the type of the genus, and there has been, I think, only another mesozoic species described. The jurassic *Corbula? planulata* of Buvignier is also a *Palæomya*.

10. *Scrobicularia*, Schuhmacher, 1817. Shell thin, rather compressed, elongately broadly oval, posteriorly slightly attenuated; hinge with one or two small cardinal teeth in front of an oblique cartilage groove; the teeth occasionally become obsolete; no lateral teeth.

11. *Lutricola*, Blainville, 1824,* (see Carpenter in Journ. de Conch., 1865, 3 ser., vol. v, p. 133). Shell transversally elongately oval, cartilage-pit more vertical than oblique, cardinal teeth lamellar. *Lut. Chemnitzii*, Desh., can be considered as the type. H. and A. Adams refer to their sub-genus *Capsa* also a few species, like *Tell. lacunosa*, Chem., *spectabilis*, Hanley, and some others which must form a sub-genus in the *TELLINIDÆ*; they have a sub-internal ligament, but not a cartilage.

12. *Iacra*, H. and A. Adams, 1858. Shell sub-trigonal, somewhat attenuated and produced posteriorly, sub-pellucid, surface of the valve divaricately sulcated, cartilage-pit oblique, narrow; one cardinal tooth in each valve in front of the cartilage-pit; lateral teeth close to the cartilage process, more prominent in the right than in the left valve.

H. and A. Adams in their "Genera" placed this form, the type of which they call *I. Seychellarum*, as a sub-genus of *Scrobicularia*, but A. Adams (Ann. Mag. Nat. Hist., xiii, 1864, p. 308,) characterizes the genus newly as having lateral teeth; thus the shells would prove to be more allied to *Syndosmya*. A strict investigation has to be made whether *Iacra Seychellarum* does really possess lateral teeth or not. If it does not possess them the name *Iacra* must stand for it, and *Ia. Japonica* of A. Adams must be separated as a distinct genus; but if *Iacra Seychellarum* is supplied with lateral teeth both must be placed in the same genus. I mention this point particularly because I dredged in the Galle harbour three species, of which one is very numerous and has lateral teeth. It is *Syndosmya strigilloides* of Vaillant and apparently closely allied to *I. Japonica* of A. Adams; another different species also has lateral teeth, but a third, of which I procured only one valve, has none. The question now arises, as I said, regarding the lateral teeth of *Seychellarum*, and in case this does possess them, a new genus must be proposed for the last named form without lateral teeth, and this will stand close to *Scrobicularia*. But unless we are certain on this point, it is of no use increasing the burden of our nomenclature. When the examination has been made, the change can be easily effected with the facts before us.

Dunker, in Mal. Blätter of 1861, vol. viii, p. 43, describes a *Strigillina lactea* from the Red Sea. He places it close to *Semele*, so I suppose the form will be identical with *Iacra*, taking this genus in the amended form and supposing that *I. Seychellarum* has lateral teeth.

The following genera† are doubtful as belonging to the present family, but from the scanty record we have of them, it appears that they would be placed more correctly here than in some other divisions of the *TELLINIDÆ*. Carpenter suggests that they may form a distinct sub-family.

* As the name *Capsa* must be retained in Bruguiere's sense for the type of Linné's *Venus deflorata*, Carpenter's reconstruction of Blainville's name may be accepted.

† Tryon in his last catalogue of the *TELLINIDÆ* refers *Edalina* and *Cooperella* to the *TELLININÆ*.

13. *Ædalina*, Carp., 1866, (Proc. Calif. Acad. Nat. Sc. for 1866,—olim *Ædalia*, Carp., 1864, and Jour. de Conch. 3^{me} ser., v, p. 134). Shell inflated, thin, equivalve, equilateral, rounded; scarcely gaping, ligament external, cartilage sub-external; hinge with three cardinal teeth in one and two in the other valve; all bifid; no lateral teeth, pallial sinus deep. The only type specimen was called *Æ. sub-diaphana*, of which the author states that it had accidentally been destroyed, but the characteristic, as recorded, is believed to be correct.

13a. *Cooperella*, Carp., 186? is considered as a sub-genus of the former; it has the cartilage sub-internal, the ligament contiguous to it, the cardinal teeth lamellar, simple, or one of them bifid. The sub-genus is probably closely allied to *Metis*, H. and A. Adams.

14. *Cycladella*, Carp., 1865, [1864?] (Proc. Zool. Soc., p. 270). Shell resembling *Ædalina* in form, thin, umbones flattened; ligament external, very thin; the cardinal teeth lie in the curve of the hinge line, together with the laterals, which are distant. Carpenter first suggested that the genus may belong to the *KELLIIDÆ* = *ERYCINIDÆ*; it is very unsatisfactorily characterized, and from the great divergency of the cardinals it is likely to be placed more correctly in the last named family than in the present one.

LIST OF CRETACEOUS SPECIES.

There are, as I stated, from mesozoic rocks no species known with sufficient accuracy which can be referred to the present family, but a few have been described from cretaceous deposits under the names of some of the genera quoted above. I quite agree with Pictet that it would not be of the least advantage to transfer those species to other genera, unless we know something more positive of their characters; I, therefore, append here a list of the cretaceous species (see Pictet Pal. Suisse, 4^{me} ser., 3^{me} pt., p. 132, &c.), without much comment.

1.—*Amphidesma tenuistriatum*, Sow., is certainly not a *Semele* (or *Amphidesma*), nor is it likely to be a *Scrobicularia*, though more similar to it in form; it may be a *Thracia* or a *Tellina*.

2.—*Lavignon rhomboidalis*, d'Orb., has originally been described by Leymerie as a *Pholadomya*, but it has more the appearance of a *Panopæa*, though it may also be shown to belong to *Gari* (= *Psammobia*), or one of the allied genera.

3-6.—*L. minuta*, *clementina*, *phaseolina*, and *sub-phaseolina* all appear to belong to the *GARINÆ*; none of them has the characteristic form of *Scrobicularia*, and the last two also resemble some species of *Lepton* and *Lasæa* (*Kellia*).

7-8.—*L. Baylei* and *Marcouti* of Coquand have quite the external appearance of *Thracia*.

9.—*Abra?* *formosa*, Meek and Hayd., (Check List of cret. fossils; Smiths. Miscell. Coll., No. 177, 1864).

I may here mention a remarkable shell described (Mem. Soc. Geol., France, 2nd ser., ii, p. 303, pl. xiv, fig. 6,) under the name of *Cyprina incerta*. The hinge of the left valve, which is unfortunately not perfect, very strongly recalls that of a *Cumingia*, and so does also the form of the shell.

No species of this family occur in the cretaceous rocks of Southern India.

B. *TELLINACEA* with a strong external ligament, but without a cartilage in the hinge.

XI. Family,—*TELLINIDÆ*.

(*TELLININÆ*, H. and A. Adams, *TELLINIDÆ* and *PSAMMOBIIDÆ* of Deshayes).

Animal with a strongly compressed lingui-form foot, the siphons long and wholly separated, the inhalant shorter, but more muscular and thicker than the exhalant; the palpi variable in size, but usually large and coarsely striated; generally with two unequal gills on each side of the body, sometimes distinct only near the posterior ends, where they are united, narrow, but usually much longer than the palpi. The shells are transversally elongated, posteriorly more or less attenuated, or truncated, gaping behind and sometimes also in front, thin, entire at the margins; beaks small, not very prominent; hinge composed of one or two cardinal teeth, lateral teeth present or wanting; ligament external on more or less prominent or thickened fulcra; pallial sinus deep and often very large.

The *Tellens* are among the oldest known shells, but the different forms which they present have been variously classified by conchologists. Lattreille first grouped most of them, then known, under a special family name, *TELLINIDÆ*; but many subsequent changes and corrections have been made by several of our best conchologists.

I have already mentioned the classification of H. and A. Adams in their admirable work, the Genera of recent Mollusca. They place our shells as a sub-family beside the *DONACINÆ*, *SCROBICULARIINÆ*, and *PAPHIINÆ*. Deshayes was the first to draw attention to the differences which exist between the animals of the group of *Gari* (his *PSAMMOBIIDÆ*) and those of other *TELLINIDÆ*; but I think that author's separation of the shells into two families is neither necessary nor fully justified by any very essential differences. Deshayes rightly says that the shells do not offer any particular distinctions, at least not such as would entitle them to rank as two distinct families, but he says that the animals of the *GARINÆ* possess small palps and two gills on each side, while all the *TELLININÆ* have large palps and only one gill on each side. This would no doubt be thought of importance, for this fact being sufficiently well established, there generally could be some distinctions pointed out in the shells which would assist in the separation. But I am afraid that the character specified regarding the number of gills is not a general one in *TELLININÆ*, and I do not even know whether it holds good at all. I have examined the animals of *Tell. rugosa*, *rosea*, and a few others, and found that the gills are in those species always long and narrow, the two plumes are grown together in front, but more or less distinctly separated posteriorly, where the gills from both sides join each other; however, even at the anterior part where they certainly appear as a single gill, the median furrow separating the two plumes can be traced without much difficulty. I hope to be able to return to this anatomical question at the earliest opportunity.

Again, as regards shells, the suggested distinction between the two divisions has been strengthened by the general observation on recent *GARINÆ*, that their hinge does not possess lateral teeth, while the *TELLININÆ*, as a rule, have them. But this character loses its importance, inasmuch as there are many *TELLININÆ* which have no lateral teeth, while, on the other hand, some of the species of *Gari* have them distinctly indicated by a thickening of the margins in front and behind the beaks.

For these reasons I prefer to follow in my present arrangement the classification suggested by Deshayes in 1830, separating, however, the *DONACIDÆ* as a distinct family according to Deshayes' more recent systematic changes. Merely in order to facilitate the grouping of the various generic forms I shall accept two sub-families, the *GARINÆ* (*=Psammobiidæ*), and the *TELLININÆ*. I look, however, upon this separation more as a matter of some (not altogether) convenience, than as being a strictly natural one; however, a third division which I shall quote under the name *CAPSINÆ*, including *Macalia*, *Gastrana*, *Capsa*, and *Lucinopsis*, appears to me more desirable. The *CAPSINÆ* are distinguished by an elongated or rounded shell; they possess one or two cardinal teeth in each valve and no distinct lateral teeth.

I may add that the separation of the two former named sub-families is also not distinctly indicated in geological history, except that some of the older secondary species seem, as to form, to agree better with the first than with the second division. Of the third division there are more fossil species known, all of which agree in general character with the recent ones.

The species of *Gari* and *Hiatula* (*=Soletellina*) form connecting links between the *SOLENIIDÆ* and the *TELLINIDÆ*, and the *CAPSINÆ* indicate a passage to the *PETRICOLIDÆ*, belonging to the next order.

a. Sub-family, — *GARINÆ*.

I shall take up this sub-family first, because the forms are more closely related to those of former genera than are the true *TELLININÆ*. Deshayes in his new edition of the Paris fossils refers to his family *PSAMMOBIIDÆ* only the genera *Psammobia*, *Sanguinolaria*, and *Capsa*; he altogether suppresses *Soletellina* as well as his formerly proposed group *Capsella*. The genera which we refer here to the sub-family answer more to those of H. and A. Adams', with a few alterations which suggest themselves consequent on more recent researches.

1. *Gari*, Schuhm., 1817, (*Psammobia*, Lam., 1818). Shell rather thin, elongated, nearly equilateral, posterior side somewhat less high, with one or more ridges running from the beaks to the infero-posterior end; surface regularly concentrically striated; hinge usually with two cardinal teeth in the right and two in the left, the posterior of which often becomes obsolete; pallial sinus large. The name *Gari* has been restricted for a large number of *Tellinoid* species, the type of which may be considered *Gari insignis*. Other species have some

peculiarities in common, and were on that account placed in distinct sub-genera; these sub-divisions appear to me rather desirable.

1a. *Psammobella*, Gray, 1851, (??=*Amphichæna*, Philippi). Shells similar to those of *Gari*, but smoother, the posterior part slightly ridged, and the termination more rounded; hinge usually with two blunt, partially grooved teeth in each valve. *G. modesta* of Deshayes may be considered as the type of this sub-genus; the forms are intermediate between those of true *Gari* and of the next sub-genus. It seems very doubtful that Philippi's name *Amphichæna* can be applied to this sub-division, when we compare the characteristic given by that author in his Manual of Conchology. I shall notice the genus further on as distinct.

1b. *Psammocola*, Blainv., 1824. Shell rather solid, with sub-parallel upper and lower margins, posterior part generally somewhat longer, obliquely truncated. The type of this sub-genus is *Psammobia maxima*, Desh., it is a form which mostly approaches some of the *PHARELLINÆ*.

2. "*Amphichæna*," Phil., 1847, (Handb. der Conch., 1853, p. 307). "Shell elongated, nearly lineal and equilateral, gaping at both ends; beaks small; cardinal teeth $\frac{2}{3}$, no laterals; ligament external, placed on slightly prominent fulcræ; two muscular impressions; pallial sinus large. This genus apparently stands between *Donax* and *Solen*;" one species, *A. Hindermannii*, is from Mazatlan. Such is the characteristic given by Philippi; I do not know the species, but it appears rather distinct from other *Psammobellæ*.

There have been a large number of fossil species described under the generic name of *Gari* or *Psammobia*, but it remains to be shown how many of them really belong to that genus, or even to this sub-family. It cannot be doubted that true species of *GARINÆ* occur in tertiary deposits, but those from cretaceous and older deposits seem to a large extent doubtful. I have ascertained that some of the cretaceous species which in external form perfectly resemble *Gari* (sub-genus *Psammocola*) do not at all belong to that genus, but to *Tapes*, or one of its nearly allied genera. In the list of the cretaceous species I shall, however, be obliged to retain some under the name *Gari*, for unless the hinges of those species have been examined, there is no advantage in shifting them to other genera.

3. *Hiatula*, Modeer, 1793, (*Soletellina*, Blainv., 1824). Shell elongated, gaping at both ends, thin, covered with a thick horny epidermis, posteriorly less high and more or less produced, flexuous and slightly carinated; hinge usually with two cardinal teeth in each valve, but the posterior in the left valve is generally smaller, laminar, and becomes occasionally obsolete; pallial sinus large.—The type of this genus, as restricted, is Linné's *Solen Diphos*. The species, as a rule, greatly resemble those of *Gari*, and could be considered only as sub-generically distinct from them, but while the latter are truly marine shells, the *Hiatulæ* generally live near rivers and in brackish water, having a thinner shell, but with more strongly developed epidermis; the posterior end of the shell is also more attenuated and flexuous than in *Gari*.

3a. *Psammotella*, Blainv., 1824. This includes a few yellowish or purplish coloured species with a thin epidermis; posteriorly slightly rostrated and rounded; the fulcrum is very strong, and the margin in front of the hinge somewhat thickened, as if indicating a lateral tooth. The type of the sub-genus is *Hiatula* (*Soletellina*) *sub-radiata*, Desh.

3b. *Psammotæa*, Lamck., 1818, (*Capsella*, Desh.; see Reeve in Conch. Icon. x). Shell transversally elongated, thin, beaks slightly prominent, the posterior side indistinctly ridged, scarcely less high than the anterior, sub-equilateral, covered with an olivaceous epidermis; hinge with one tooth in the left and two in right valve, all three short, blunt, and grooved; pallial sinus deep. This includes a number of eastern shells, in which the epidermis is strongly developed and the shelly part thin; they appear partially to live in brackish water; *Psammotæa* *Layardi*, Desh., may be considered as the type.

4. *Sanguinolaria*, Lam., 1799. Shell largely oblong, thin, posteriorly considerably attenuated and sub-angular; hinge with two approximate, partially bifid teeth in each valve; pallial sinus very wide, somewhat irregular. Reeve describes five species, most of which are rose coloured. *S. sanguinolenta*, Gmelin, is the type of the genus; the shells are distinguished by their largely oval and compressed form and their thin structure.

5. *Elizia*, Gray, 1852. Shell compressed, thin, like *Sanguinolaria*, but sub-orbicular in shape, and not ridged posteriorly; the anterior side much shorter; hinge with three teeth in the left and two in the right valve; in the former the central indistinctly bifid, and the posterior are in both almost horizontally prolonged. Reeve describes two species as *Soletellina* (= *Hiatula*), the well known *E. orbiculata* from Sumatra, and another, *E. reversa*, from Malacca; the latter seems hardly to differ from the former.

b. Sub-family,—TELLININÆ.

In this sub-family are included the species which are by older conchologists usually called *Tellina*. The animals of these species have, as a rule, very long, thin siphons with entire orifices, and the two plumes composing the gills anteriorly grown together in one plane, but posteriorly more or less free, palpi very large; the shells are peculiarly attenuated and compressed posteriorly; the surface is very regularly concentrically striated, and in the larger number of them the hinge is furnished with lateral teeth; those of the left valve are, however, generally smaller or even obsolete; the posterior gape is always distinct, though narrow, but the anterior is only occasionally traceable; the ligament is strong, the fulcra not very prominent, the pallial sinus usually very large. Their geographical distribution is world-wide, and the first species occur in the jurassic period; they are, as a rule, true marine shells.

6. *Macoma*, Leach, 1819. Shell slightly inflated, or compressed, cardinal teeth small, sometimes nearly obsolete, the laterals are, as a rule, not developed at all, occasionally there is a thickening of the margins observable. The shells

are usually covered with a rather thick epidermis, and some of them live in brackish water.

7. *Tellidora*, Mörch, 1851 (?). Shell sub-triangular, or rapidly contracted posteriorly, very thin, transparent; surface concentrically plicated; hinge with two cardinal teeth in each valve, the posterior in the right valve being usually obsolete; posterior lateral teeth more strongly developed than the anterior. The type of this genus is *Tell. Burnetti*; it is a markedly different shell from other *Tellinæ* in form and structure, but it passes gradually into the typical forms of that genus through such species as *Tell. crystallina*, Chem.

8. *Tellina*, Linné, 1758. The form of the shells varies from sub-orbicular to transversally much elongated, but the posterior end is always narrower, somewhat contracted or flexured, a ridge running from the beaks to the postero-inferior end; they are either equivalve, or often the posterior end is the shorter, but sometimes it is longer than the anterior; they are always more or less laterally compressed; the cardinal teeth are generally well developed, two in each valve, and of the same number are the laterals, but the latter sometimes become obsolete. It is almost a general rule that the lateral teeth of the left valve are smaller than those of the right. The numerous sub-genera which have been established seem to me to be extremely convenient in the grouping of the many species of *Tellinæ*, and some, as, for instance, *Macoma* and *Tellidora*, are, I believe, deserving of being separated into distinct genera. I may also especially mention *Mæra*, *Arcopagia*, (in parte), and *Omala*, which will probably have to be separated as distinct genera. However, as the correct comparison of many of our fossil species still depends upon our obtaining much better materials than those now available, it does not appear desirable to introduce at present those changes indicated.

H. and A. Adams restrict the name *Tellina* for a few species of the type, *T. radiata*, being transversally elongated, with sub-parallel upper and lower edges, and well developed cardinal and lateral teeth. The other sub-genera are—

8a. *Tellinella*, Gray, 1852; the type being the well known *T. virgata*, posteriorly prolonged, and more or less rostrated; the lateral teeth are stronger in one valve than in the other.

8b. *Peronæoderma*, Poli, 1795. Posterior side of the shell angular, not much produced; lateral teeth in one (usually the left) valve almost entirely obsolete. *T. punicea*, Born, is the type. This sub-division is not equally characteristic as others, and most of the species could be classed with the former.

8c. *Mæra*, H. and A. Adams, 1852. Posterior end remarkably shortened, beaks directed backwards, ligament supported by small fulcra, cardinal teeth two in each valve distinct, lateral smaller in the left valve, but distinctly traceable. I have examined two small species from the eastern seas; they externally very much resemble a *Donax* (therefore *Donacilla* of Gray), but the shells are thin as in other *Tellinæ*.

8d. *Palæomæra*, Stol., 1870. Shell elongated, hinder part shorter, the upper declivity slightly convex, posterior end sub-truncate, beaks directed forwards;

ligament situated on thickened but not prominent fulcra; hinge with one anterior, long, lamelliform tooth in each valve, bifid in the right, single in the left valve, posterior cardinal teeth not distinctly traceable in either valve; laterals less distinct in the left valve. This is based upon the cretaceous *Tellina strigata* of Goldfuss (see Peträf. Germaniæ, pl. 147, fig. 18). In form it very much resembles *Mæra*, but the hinge presents some marked differences, as noticed above.

8e. *Arcopagia*, Leach, 1827, (teste Brown). There have been a number of very different shells described under the name of *Arcopagia*. I shall here restrict that name to those forms which are more or less closely allied to the type species, *Tell. crassa* of Pennant. These are more or less sub-orbicular, with convex valves, usually rough surface and always with a posterior plicature; the cardinal and lateral teeth are distinct; of the latter those of the left valve are smaller than those of the right, but usually distinctly traceable. Even as restricted in this way there are two sections of shells of a somewhat different aspect; the one is almost orbicular like *Tell. crassa*, *discus*, and *scobinata*; the other is posteriorly more produced, resembling the sub-genus *Tellinula*, like *Tell. lingua-felis* or *rugosa*; but the shells pass so gradually one into the other that no further separation appears advisable. Both forms are represented in tertiary and cretaceous rocks.

8f. *Linearia*, Conrad, 1860, (Journ. Acad. Nat. Sc., Phil., iv, p. 279). Shell elongated, sometimes roundish, not peculiarly thick, rounded on both ends, surface partially or wholly radiately ribbed, posteriorly not, or very indistinctly, flexuous; anterior cardinal teeth in both valves elongated, bifid, much smaller in the left valve; posterior cardinal small, but larger in the left than in the right; lateral teeth much thinner in the left than in the right valve, sometimes almost obsolete in the former. This ought to include a large number of fossil species which have been described as *Arcopagiæ*; the want of posterior flexure or plicature and the usual radiate ribbings near the terminations of the shell particularly characterize those species. Among recent shells they are represented by *Tell. concentrica*,* Gould, (not *id.* Reuss or d'Orb.), and one or two others. For many years palæontologists have separated these shells from *Tellina* and applied to them the name *Arcopagia*.

The hinge-teeth vary a great deal, sometimes the posterior cardinal tooth is very elongated and laminar in the right valve, at other times it is nearly obsolete. In the left valve the posterior cardinal is always short and thick, sometimes grooved or bifid.

Conrad instituted this genus for a North American cretaceous species, and most of the known forms belong to the same geological period. Conrad's characteristic is, however, in some respect unintelligible; he says: "oval or oblong; cardinal teeth in the *left valve* two, the anterior one elongated, the other under the apex small and bifid. This shell of which I have *only the right valve* belongs to a cretaceous group which d'Orbigny has referred to the genus *Arcopagia*, &c." It is probable that the

* I only know this species from the figure in Chenu's Manual.

reference to a *left valve* is to that figured by d'Orbigny (Pal. Franç., foss. cret., iii, pl. 378, fig. 5); in such a case, however, it ought to have been stated, for it is a very great difference to draw up a characteristic from the actual specimen or from a figure without consulting its original, but Mr. Conrad seems at such occasions often to indulge in the mysterious; my characteristic quoted above has been taken from very well preserved specimens of both valves of *Tell. costulata* of Goldf. and from our own Indian forms.

8g. *Phylloda*, Schuhmacher, 1817. Shell oblong, much compressed, posterior side carinated; hinge with the primary teeth divergent, lamellar; one lateral tooth in the right valve only. Type *Tell. foliacea*, Linn.

8h. *Angulus*, Mühlf., 1811, (*Tellinula*, Chem., *Fabulina*, Gray). This includes a number of small, thin, smoothish shells (like *T. fabula*, Gmelin, or *T. juvenilis* of Hanley), sub-orbicular, or elongated, with a posterior plicature; the cardinal teeth are small; of the laterals there is usually only one (the anterior, rarely the posterior) in the right valve well developed, the other is mostly obsolete. This section of *Tellinæ* is sometimes determined with very great difficulty: some of the species greatly resembling small *Macomæ*; and perhaps *Macoma* ought to range only as a sub-genus here or near *Peronæa*.

8i. *Tellinimera*, Conrad, 1860, (Jour. Acad., Phil., 2nd ser., iv, p. 278). The author describes two species, *T. limatula* and *eborea*, under this name: they both have an elongated sub-trigonal form, and the shells are said to be thin. Of the former species a right valve is described, possessing "three cardinal teeth, the shortest one extending to the apex." Of the latter a left valve appears to be figured; the shell is said to have the anterior cardinal tooth slightly oblique. No lateral teeth are said to occur in the former, and no mention is made of their existence in the latter. The shells resemble *Angulus* a great deal, but the present characteristic appears insufficient to compare *Tellinimera* with any of the other sub-genera of *Tellina*.

8k. *Tellinides*, Lamarck, 1818. Shell transverse, posterior part somewhat attenuated and truncated at the end; hinge with one approximate lateral tooth. Type *T. timorensis*, Lam.

Tellinites, Schloth., 1820. This name has been in use by various authors since nearly two centuries ago, but Schlotheim reserved it for certain fossil, especially *palæo-* and *meso-zoic* species of *Tellinæ*, and similar shells. The definition is uncertain, for I am not aware that in any of the species the hinge had been examined. McCoy (Brit. Pal. Foss., p. 286,) refers to it a species, *T. affinis*, which rather appear to belong to the *SOLEMYIDÆ*; other species, however, have more the aspect of *Tellinæ* and still more that of *Tellinomya*.

8l. *Homalina*, Stoliczka, 1870, (*Homala*, ^{Murch.} apud H. and A. Adams). Shell elongated, anterior side short, broadly rounded, posterior prolonged, attenuated with a more or less distinct marginal plicature, narrowly rounded posteriorly; cardinal teeth small, one approximate lateral tooth in the right valve. *T. triangularis*, Chem., is the type. This is a very characteristic section of *Tellina*;

Homalina is a section of *Tellina* with a rounded hinge, and elongated to the anterior side.

the shells resemble externally *Gastrana*, but are much thinner. H. and A. Adams apply, according to Mörch, the name *Homala*, which is a corrected name of Agassiz for *Omala* of Schuhmacher, for which the type *T. planata* of Linné has been taken, and which is therefore identical with the next sub-genus.

8m. *Peronæa*, Poli, 1791. Shell oblong, thin, anterior side short, posterior elongated, sub-angular, with a slightly elevated marginal plicature; ligament in a long deep groove; lateral teeth obsolete, cardinal elongated, but not very prominent. Type *T. planata*, Linn.

8n. *Metis*, H. and A. Adams, 1858. Shell elongately oval, moderately inflated, anteriorly somewhat produced and rounded, posteriorly truncate, shortened, and more or less plicated; ligament large, in a deep groove, fulcra thickened inside; hinge in the right valve with two diverging teeth; in the left the middle tooth is distinct, but the anterior is represented only by a thickened margin; not a trace of lateral teeth; muscular impressions and pallial sinus large. This genus is very characteristic and considerably different from other *Tellinæ*; its type is *Tell. Meyeri*, Phil., and such forms as *T. lacunosa*, Chem., *Tell. spectabilis*, and many others of the same type, also appear to belong to it, but I have not seen the last named shell. A species similar to *spectabilis* occurs fossil in the tertiary deposits of Burma; it has the ligament marginal and almost covered by the upper edge. Hörnes says (Fossile Moll. des Wiener beckens, vol. ii, p. 92,) that he satisfied himself of the identity of the miocene form with the recent one. I have just now no materials for comparison, but as far as I can remember the shell there are some not unimportant differences in the fossil form. In any case the Vienna type is more equilateral than any recent specimen I have seen.

H. and A. Adams refer to the sub-genus *Metis* merely the single species *Tell. Meyeri*, Phil., and quote others like *lacunosa*, *ephippium*, &c., as a sub-genus of *Scrobicularia* under the name *Capsa*, Bosc. I had no opportunity of examining all the species, but those which I have mentioned and a few others certainly are more allied to the *TELLINIDÆ* than to *SCROBICULARIIDÆ*; they have the ligament soft or spongy, situated in a deep groove, sometimes merely covered by the free sharp edges of the fulcra, but they have no cartilage proper, at least not separated or lodged in a special cavity. The situation of the ligament is sub-internal, perfectly similar to that of many *Lucinæ*.

789. *Mactromya*, Agassiz, 1842, (see Pict. Pal. Suisse, 3^{me} ser., p. 154). Shell elongated, equivalve, solid, sub-equilateral, posterior side somewhat longer, upper margins sloping, almost straight, both ends rounded; hinge-teeth not known (?? wanting), an oblique internal rib in front of the beaks; ligament strong, external. Pictet and Campiche have again introduced Agassiz' genus for the type species *M. Couloni*, and placed it in the *TELLINIDÆ*. The authors have examined specimens with the shell, which is very thick, only exhibiting striæ of growth; they correctly conclude that the shell cannot belong to the *ANATINIDÆ*, which are all of a particularly thin structure. It is not easy to find anywhere else a place for the genus except in the *TELLINIDÆ*, although no hinge-teeth have

as yet been observed: I do not think that the anterior internal rib is of any generic importance, for such ribs are not unusual in various species of *Tellinæ*. In general form *M. Couloni* resembles our *Palæomæra inconspicua*, but this has all the characters of the latter sub-genus, the hinge-teeth being distinct; still it is the only shell I know which can be compared with the European type species. Possibly *Mactromya* may stand near *Metis*, for in some species of this sub-genus the few cardinal teeth become almost quite obsolete, but then it is again to be observed that all species of *Metis* are thin shells.

10. *Strigillina*, Turton, 1822. Shell sub-orbicular, posteriorly slightly produced and narrower; surface glassy and divaricately striated; hinge with the cardinal and lateral teeth well developed; sometimes there is in each valve only one strong, sometimes two cardinal teeth. *Strig. carnaria* is the type of this genus. The shells are very characteristic, and though resembling in shape and dentition *Tellinæ*, the glassy divaricately striated surface is so peculiar that a generic separation seems advisable. They are externally very much like *Iacræ* and other divaricately striated species of the *SCROBICULARIIDÆ*, and must be considered as truly representative types.

c. Sub-family,—CAPSINÆ.

The shells included in this sub-family are characterized by an inflated form of the valves, these being generally radiately striated; the hinge only possesses cardinal teeth, but the animals do not differ from typical *TELLININÆ*.

11. *Macalia*, H. Adams, 1860, (Proc. Zool. Soc., Lond., p. 369). This genus has been proposed for the type *Tell. Bruguieri*, Hanley. The shell is sub-orbicular, rather solid and inflated, posteriorly with a moderate ridge, nearly equivalve, the beaks are prominent, the ligament situated in a deep groove; the hinge with two very strong cardinal teeth in each valve.

12. *Gastrana*, Schuhm., 1817. Shell transversally elongated, often sub-trigonal, inequilateral, more or less inflated; hinge with two diverging cardinal teeth in each valve, the anterior in the left usually bifid and stronger than any of the others; no lateral teeth are present. The best known species, *Gast. fragilis* of Linné, may be considered as the type of the genus. Fossil species are known as yet only from tertiary deposits, but it is possible that some of the species described from older formations as *Capsa* belong to *Gastrana*. The recent species burrow in sand and mud; I met with one species near Akyab (Arracan coast) burrowing in a soft sandstone bank in company with a *Petricola*.

13. *Capsa*, Bruguière, 1791, (*Asaphis*, Modeer, 1793). Shell oblong, ventricose, equivalve, posteriorly widely gaping; surface of valve radiately striated; hinge with two diverging cardinal teeth in each valve, pallial sinus spacious. Linné's *Venus deflorata* (*Sanguinolaria rugosa* of Lamarck) must be considered as the type of this genus. Reeve describes only two species, H. and A. Adams quote four, but they may all be considered as varieties of the same species. A large number of fossil species had been described under the generic name *Capsa*,

but not many have as yet been with sufficient certainty proved to belong to that genus. Deshayes' *Capsa minima* may rather be a *Psammocola* or *Psammobella*, but it has not at all the appearance of a recent *Capsa*. There are also a few species from cretaceous deposits somewhat resembling *Capsa*, but those from older formations are very doubtful; most of the fossil species are without radiating striæ, and their relations to *Gastrana* have in many cases yet to be fully ascertained.

14. *Lucinopsis*, Forb. and Hanley, 1848, (*Mysia apud* Gray, *Lejonkairia*, Desh). Shell sub-orbicular, rather compressed, thin, surface concentrically and often also radiately striated; hinge with two cardinal teeth in the right and three in the left valve; pallial sinus deep, ascending. *L. undata*, Penn., may be considered as the type of this genus. The shell has externally a very great resemblance to some *DOSINIINÆ*, especially *Cyclina*, and also to the fossil species which Conrad called *Cyprimeria*, as well as to *Clementia* in its structure, but according to Clark the animal is quite similar to that of other *Tellinæ*. The one bifid tooth in the left valve certainly greatly recalls *Tellina*.

Considering fossil evidence the *TELLINIDÆ* do not appear to be so old as many other apparently more highly organised *Pelecypoda*, for instance, the *ANATINIDÆ*. With the exception of a few doubtful forms which I stated to have occasionally been referred to *Tellinites*, and a few others called *Psammobia* (= *Gari*), we have no certain proof of their occurrence in palæozoic rocks. As regards species from triassic and jurassic deposits hardly any different assertion could be made: there are more forms which resemble *GARINÆ* than *TELLININÆ*, but I am rather in doubt whether many of those species belong to *Gari*; they are, as already alluded to, more probably referable to some of the compressed forms of *TAPESINÆ*.

In the cretaceous rocks we have several well marked types, representing a good number of the genera and sub-genera of *TELLININÆ*, but I do not know whether the same could be said as regards the *GARINÆ*. I have not met with a single species which I could with sufficient certainty refer to *Gari* (*Psammobia*), and so far as I know all the other determinations are simply based upon the external resemblance of the shells. Among these, forms resembling *Psammocola* and *Psammobella* mostly occur. With regard to the cretaceous *TELLININÆ* proper some of the sub-generic types of *Tellina*, which are at present less numerous than others, were then more prevalent, such as *Mæra*, *Linearia*, *Angulus* and *Homalina*; some like *Palæomæra* appear to be peculiar to this formation, while others like *Peronæoderma*, *Tellinella*, and *Arcopagia* are more rarely represented.

In tertiary deposits we already meet with a fauna greatly resembling the present one in generic types, but not nearly so numerous in species. Large additions to this fauna have to be expected from the examination of the tertiary deposits of India, and no doubt also of other tropical countries. The miocene species of the European deposits very much resemble those now to be found recent in tropical countries, and several species are identical. What results the tropical miocene fauna will give remain yet to be shown.

All *TELLINIDÆ* are inhabitants of sandy shores; they all bury in mud, and the greater number are purely marine species. Of the *GARINÆ* which are more numerous in Australian seas than anywhere else, there are about 120 species known; of *TELLININÆ* which are in all tropical seas numerous, but largest and finest in the eastern seas, there have been as yet about 360 species described.

CRETACEOUS SPECIES OF *TELLINIDÆ*.

Pictet and Campicche in their review of the cretaceous species of this family refer them to the genera *Tellina*, *Arcopagia*, *Psammobia*, *Sanguinolaria*, and *Mactromya*, (see Pal. Suisse, 4^{me} ser., 3^{me} part., pp. 133, &c.).

1.—*Mactromya Couloni* is the type of the genus; no other species is as yet known, and it is no doubt necessary to be very careful in transferring an imperfect fossil shell from one genus into another, for the confusion is in such cases often endless, and no benefit results either to the conchologist or the geologist.

2.—Of *Sanguinolaria* also only one species has been described, *S. cretaceus*, Conrad, from Alabama; it has quite the form of recent species of that genus, but the hinge-teeth have not been observed on the fossil. I cannot see for what reason the shell has been referred to *Cyprimeria* by the same author (Am. Jour. Conch., iii, p. 9).

Gari and allied genera. I have already mentioned that there is great difficulty in determining which of the species usually quoted as *Gari* (= *Psammobia*) really belong to that genus and which to others. Judging from the preparation of the hinge-teeth of the two species which occur in the Austrian Gosau formation, and of three species from the South Indian cretaceous rocks, I came to the conclusion that these species do not even belong to the sub-family *GARINÆ*, but must be classed in a separate genus in the *TAPESINÆ*, (family *VENERIDÆ*). However, from want of sufficient data regarding the hinge-teeth of other species, I shall be obliged to retain here those species which are closely allied in form to *Gari* and others, though this statement must be accepted with the distinct understanding that there is as yet not a single case known in which one of those species has been satisfactorily ascertained as belonging to any of the genera of the *GARINÆ*.

3-5.—*Gari Guilleroni*, *tenuis* and *Valangiensis*, have the general form of *Psammocola*, but are rather less high.

6-8.—*Gari Escheri*, *intermedia* and *Studeri*, have the posterior end radiately ribbed; there is a large number of such recent forms of *Gari*, they are chiefly of small size.

Gari compressa, d'Orb., sp., *Solen elegans*, Math., [non d'Orb. or Desh.], *impar*, Zittel (= *elegans*, d'Orb.),* *discrepans*, Duj., *Arnaudi*, Coq., (apparently closely allied to the last), and *Suessi*, Zitt., &c., are all species of *TAPESINÆ*, as I shall state in more detail subsequently.

Guéranger's (Album paléont., 1867, pl. xv.) three species, *Capsa Cenomanensis*, *Colonæ* and *concentrica*, are closely allied to d'Orbigny's *elegans* = Zittel's *Ps. impar*, and no doubt also belong to the same type of *TAPESINÆ*.

Gari texta, Gabb, (Pal. Calif., I, p. 155,) has the general form of the genus, but the posterior plicature is apparently indistinct, as in *Hiatula*.

I may here mention the peculiar shell described by Nilsson as *Venus? eruta*; it may prove to be a species of the *GARINÆ* (Petr. Suec., p. 17).

* Matheron's name *elegans* must stand for the *Tapes*-form; Deshayes' species *elegans* is a *Gari*; d'Orbigny's name *elegans* was changed into *impar* by Zittel, who (Denksch. Akad., Wien, vol. xxiv, p. 120,) identifies the Gosau with the French species, although, judging from the figures, there are considerable differences between the two; the author does not say whether he had compared authentic specimens of the latter with the former.

*Tellina** and allied genera.

9.—*Tell. Carteroni*, d'Orb., is a typical *Tellina*; the casts show impressions of the cardinal and lateral teeth in both valves.

Tellina Sobralensis, Sharpe, which is quoted by Pictet and Campiche, and which had been originally described as coming from cretaceous beds, is, according to a subsequent note of the author, a tertiary fossil from the "Almada beds" at Portella. It is a fine example of the sub-genus *Metis*, and closely allied to the recent *M. lacunosa*.

10.—*Tell. Moreana*, d'Orb., (? *Peronæoderma*).

11.—*Tell. phaseolina*, P. and C. (? *Peronæa*).

12.—*T. gracilis*, Sow., sp., has the general form of a true *Tellina* (non *T. gracilis*, Reeve's Conch. Icon., 1867).

13.—*Tell. sub-tenuistriata*, d'Orb., (*Amphid. tenuistriata*, Sow.) may either be a *Thracia*, or, possibly, a *Peronæoderma*.

14.—*Tell. striatuloides*, Stol., is a *Tellinella* (*Tell. striatula*, Sow., non *idem* [*Tellinella*], Lam.).

15.—*Tell. Renauxi*, Math., appears to be also a *Tellinella*.

T. Venei, d'Archiac, is evidently a species of the *TAPESINÆ*.

16.—*T. fragilis*, d'Arch., [non *T. (Gastrana) fragilis*, Linn.], appears to be a *Mæra*.

17.—*T. Rouyana*, d'Orb., may most likely be a species of *Peronæa*.

18.—*T. Goldfussi*, Römer, is a very indistinct cast; it has the appearance of a *Tellinella*.

19.—*T. pseudo-plana*, d'Orb. (*plana*, Röm.) is like a *Mæra*. I have not been able to examine the hinge.

20.—*T. tenuissima*, Reuss. I do not know a single species of *Tellinæ* which approaches this peculiarly rounded form; in some respects it resembles *Macalia*, in others *Gastrana*, but the examination of the hinge-teeth is necessary to insure correct generic determination.

Tellina Reichii, Röm., is most likely a *Corimya*.

21.—*Tell. ? semistriata*, Gümbel, 1861, (non *id.* Desh., 1864). From the reference to *Tell. rostralina*, as to form, the species seems to belong to *Tellinella*.

22.—? *Tell. subradiata*, Röm. (*Donax id.*, Röm.) is evidently a species of *Palæomæra*, and closely allied to *Pal. strigata*, Goldf., except that Römer represents his species more angular at the anterior end. Pictet and Campiche (loc. cit., p. 141.) add *T. æqualis*, Mant., and *T. ? Vectiana*, Forb. The former has never been figured or described, the latter must be a *Homalina*, if it at all belongs to the *TELLININÆ*.

23.—*Tell. strigata*, Goldf., is the type of *Palæomæra* (see p. 116).

24.—*Tell. syriaca* is described by Conrad (Off. Report, &c.) from Palæstine.

25.—*Tell. Stoliczkana* (non *Stoliczkai*!), Zitt., 1864, (Denksch. Akad., Wien, xxiv, pt. ii, p. 119.) is of a broadly triangular form, has very strong lateral teeth, but an indistinct posterior plicature; it may be classed with *Peronæoderma*.

26.—*Tell. gibba*, Coquand, 1865, (Monog. de l'étage Aptien de l'Espagne, p. 101.) is apparently a *Tellinella*.

Species of *Arcopagia* and *Linearia* (see Pal. Suisse, 4^{me} ser., p. 143).

27-28.—*Arcopagia sub-concentrica* and *Rouliniana* of d'Orbigny are *Linearia*. *Arc. Ceno-manensis*, *numismalis* and *rotundata* of the same author are to all appearance *Cyprimeria*, which belong to the *VENERIDÆ*, as will be stated in more detail hereafter, though Conrad considers the genus to be a member of the *TELLINIDÆ*.

29-37.—*Arcopagia semiradiata*, Math., sp. (*Venus id.*), *A. Michelini*, Coq., *A. gibbosa*, d'Orb., *A. circinalis*, Duj., sp., (d'Orb.), (= *Tell. clathrata*, Reuss, Böhm. Kreide, pt. ii, p. 19),

* There are remarkably numerous repetitions of names among fossil and recent *Tellinæ*; even in Deshayes' last edition of the Paris fossils such instances are not very uncommon.

A. inæqualis (*Tel. inæqualis*, Sow., non *id.* Hanley), *A. subdecussata*, Röm., sp., *A. costulata*, Goldf., sp., (*Tellina*), *A. concentrica*, Reuss, 1843 (non *id.* Gould, 18??), and perhaps also *A. lamellosa*, Reuss, sp. (*Solen*), are all species of *Linearia*, but I expect that several species will be found identical among themselves, such as those described by Reuss and Römer from Germany with those of d'Orbigny from France.

38-39.—*Ar. biradiata* and *fenestrata*, Zittel, (Denksch. Akad., Wien, 1864, xxiv, pt. ii, pp. 118—119,) are also *Linearia*; the same author redescribes *Ar. semiradiata*, Math., from the Gosau.

40.—*Linearia* (*Arcopagia*) *multilineata*, Coq. (Mon. étage Aptien, 1865, p. 98,) has the general form of *L. circinalis*, but is said to have the left valve more convex than the right one.

41-42.—*Ar. reticulata* and *Ar. crenulata*, Guéranger, (Album paléont. de la Meuse, 1867, pl. xv, figs. 13 and 16,) are *Linearia*. The author also figures *Lin. semiradiata*, Math. sp., under the name *Arc. radiata*, d'Orb.

43-44.—*Tell. parallela* and *Refanensis*, Coquand, from Algeria are, if they belong to the *TELLINIDÆ*, species of *Mæra*.

45-53.—Meek (Check list of N. American cretaceous fossils, Smiths. Misc. Coll., No. 177, 1864, p. 14,) quotes the following: *Tell.?* *Cheyennensis*, *T. Eufalensis*, *æquilateralis*, *nitidula*, *Ripleyana*, *scitula*, *? subelliptica*, Meek and Hayd., [non *T. subelliptica*, Sow., apud Reeve], (*Tellinimera*) *eborea*, (*Tellinimera*) *limatula*.

54-57.—The same author also quotes *Arc. texana*, Römer, which more likely belongs to *Cyprimeria*; further *Linearia metastriata*, *Lin.?* *cancellato-sculpta*, and *L.?* *irradians*; the last two and especially the last mentioned will probably be shown to belong to the *TAPESINÆ*.

58-72.—Gabb describes in Palæont. of California, vol. i, pp. 154, &c., and vol. ii, pp. 182 and 183, *Tell. longa*, *Rémondii*, *Hoffmanniana*, *monilifera*, *ooides*, *Mathewsonii*, *decurtata*, *? quadrata*, *Ashburnerii*, *Whitneyi*, (*? Sanguinolaria*) *parilis*, *Hornii*, *Californica*; *Tell. æqualis* and *? undulifera*. All these represent several sub-genera of *Tellina*, but especially *Tellinella*, *Homalina*, *Peronæoderma*, possibly also *Phylloda* (*T. monilifera*) and *Palæomæra* (*T. ooides*).

Tell. Bogotina, d'Orb., (Pal. Am. meridionale, pl. xviii, figs. 16-17,) I have already mentioned has more the character of a *Corimya*.

73-74.—*T. Largillierii* and *Arc. Valdiviana*, d'Orb., (Voy. Astrol. Paléont., pl. v, figs. 5-8). The former appears to be a *Tellinella*, the other has no radiating striæ, and is, therefore, more probably a *Tellinides* or *Homalina*, than a *Linearia*, with which it also agrees in form.

To this number probably *Tell. albaria*, *arctata*, *bitruncata*, *emacerata*, *obruta*, *Oregonensis*, and *subnasuta* from Mr. Conrad's lower eocene rocks have to be added (see Conrad's Check list, &c.; Smiths. Misc. Coll., No. 200, 1866, pp. 7-8).

74a

CAPSINÆ.

75.—*Capsa texana*, Conrad (Emory's report, p. 164).

76-77.—*Asaphis undulata* and *multicostata*, Gabb, (Pal. Calif., vol. i, p. 154, and vol. ii, p. 154, &c.); both have very much the form of *Linearia*, especially the last one; of the first Gabb figures the hinge without lateral teeth.

Capsa gigantea, Müller (Monog. der Pet. der Aach. Kreidef. Supplem., 1859, p. 15,) appears to be a *Protocardia*.

78-88.—The following species occur in South India: *Tell. (Tellinella) petrosa*, *T. (Tellinella) Arcotensis*, *T. (? Peronæoderma) scitulina*; *T. (Per.) primula*; *T. (Arcopagia) mendosa*, *T. (Arcopagia) discites*; *T. (Tellinides) adpressa*, *T. (Palæomæra) inconspicua*, *T. (? Homalina) undata*, *T. (Linearia) semisculpta* and *T. (L.) sculptilis*. The species are almost in an equal number distributed over the three geological groups of the cretaceous deposits. *Tell. Pondicherriensis*, Forb., and two other similar species will be described in the sub-family *TAPESINÆ*.

TELLINA, *Linné*, 1758.(Including sub-genera, *vide* p. 116, &c.).✓1. TELLINA [TELLINELLA] PETROSA, *Stoliczka*, Pl. XVI, Figs. 27-28.

Tell. testa elongata, multo longiore quam alta, parte antica paululum longiore quam postica, utrinque distincte attenuata, marginibus superioribus declivis, sub-rectis, antice anguste-rotundata, postice sub-angulata, plicatura paulo elevata; margine inferiori lentissime curvato; superficie striis crassiusculis lamelliformibus confertis notata.

This is a rather elongated form, of the type of the recent *Tell. rostrata*, nearly or fully double as long as high; with the upper edges descending gradually and meeting at the beaks under an angle of about 132 degrees; the anterior edge is somewhat convex, the posterior nearly straight; the anterior end is rounded, the posterior obtusely angular; the inferior margin is very slightly curved. The shell is thin, though not particularly so; the surface is covered with concentric lamellar striæ; the posterior plicature is slightly elevated, though distinct. I have not been able to observe the hinge of this species, but there can be little doubt that it belongs to the sub-genus *Tellinella*. On the specimen represented in fig. 28, which is a cast, the lateral teeth are observable as impressions.

Locality.—Garudamungalum, in a bluish calcareous sandstone.

Formation.—Trichinopoly group.

✓2. TELLINA [TELLINELLA] ARCOTENSIS, *Stoliczka*, Pl. V, Fig. 2.

Tell. testa transversaliter elongata, valde compressa, fere æquilaterali, antice latiore, rotundata, postice angustata, sub-rostrata; prope marginem distincte sulcata; umbonibus prominulis, lateribus superioribus paululum declivis, fere rectis, margine postico antice convexo, postice insinuato; superficie striis confertis, subtilissimis concentricis eleganter notata. Cardo in valva sinistra duobus dentibus cardinalibus atque duobus lateralibus elongatis, sed paulo prominulis, instructus.

Shell thin, very much compressed, transversally elongated, nearly equilateral, anteriorly rounded and broad, posteriorly gradually attenuated, angular, a distinct groove, bounded on either side by a moderately elevated ridge, running to the posterior end; beaks prominent, pointed, the upper sides nearly straight, descending, meeting at the beaks under an angle of 135 degrees; lower margin anteriorly convex, posteriorly flexuous, insinuated; surface minutely and very regularly concentrically striated. The hinge has in the left valve as usual two cardinal and two slightly prominent lateral teeth.

This is a true species of *Tellinella*; it greatly resembles several recent species.

Locality.—Ninnyoor, in a white earthy limestone.

Formation.—Arrialoore group.

- ✓ 3. TELLINA [? PERONÆODERMA] SCITULINA, *Stoliczka*, Pl. IV, Figs. 10-13, and Pl. XVI, Fig. 30.

Tell. elongata, moderate compressa, crassiuscula, inæquilaterali, parte antica (?) breviori, ad marginem rotundata, parte postica producta et attenuata, sub-angulata, plicatura haud distincta; marginibus superioribus fere rectis, declivis, angulum 130° formantibus; margine inferiori convexiusculo, superficie striis distantibus, lamellosis, crassiusculis seu corrugatis ornata. Cardo duobus dentibus cardinalibus ac lateralibus in utraque valva instructus.

Shell elongated, moderately compressed, more than one-third longer than high, marked with distant lamellar or rugose concentric striæ; beaks prominent, superior declivities meeting with an angle of 130 degrees; the anterior side shorter, broadly rounded; posterior somewhat produced and attenuated, hardly flexuous, inferior margin almost evenly convex. The hinge has two cardinal and two lateral teeth in each valve, the posterior cardinal in the left and the anterior in the right are stronger than their respective anterior and posterior; the laterals of the left valve are considerably smaller than those of the right one, but quite distinctly traceable; they are elongated, thin, marginal.—The somewhat solid structure of the shell as compared to its size, and the peculiar apparently rough striation, readily distinguish this species from any other known. In form it closely resembles the Gosau *Tell. Stoliczkana*, but all our specimens are considerably longer in proportion to the height:—figure 10 on pl. v is in that respect somewhat incorrect, and a second representation of the same specimen is given on pl. xvi, fig. 30. The posterior plicature is indistinct. As to form the shell bears a great resemblance to a *Mæra*, but I could not satisfactorily prove that the shorter side is the posterior; to all appearance the shorter side seems in our shell to be the anterior one, at least there is in one specimen (fig. 10a, pl. v,) a small ridge behind the umbones which can only be explained as a fulcrum; I have not been able, however, to see the pallial sinus.

Locality.—Comarapolliam, in a light coloured sandstone.

Formation.—Arrialoor group.

- ✓ 4. TELLINA [TELLINIDES] PRIMULA, *Stoliczka*, Pl. V, Fig. 1.

Testa ovata, fere æquilaterali, tenuissima, valde compressa, antice rotundata, postice obtuse ac late truncata, jugo paululum elevato ab umbonibus ad marginem postero-inferiorem decurrente instructa; marginibus superioribus paululum declivis, lente curvatis, margine inferiori convexo, postice vix flexuoso; superficie striis æqualibus, subtilissimis concentricis induta. Cardo in valva dextra duobus dentibus cardinalibus distinctis et uno postico laterali instructus, dente laterali antico fere obsoleto.

Shell oval, nearly equilateral (the posterior part very little shorter than the anterior), about one-third longer than high, very thin and compressed; the

beaks are very slightly prominent, the upper margin somewhat curved, but very gradually descending; the anterior side is rounded, the posterior convexly truncated, with a slightly elevated, rather broad ridge running from the beak to the postero-inferior margin. The surface is very elegantly and most minutely concentrically striated, the striæ being extremely fine, but distinctly elevated and separated by broader, though deep furrows. The hinge of the right valve has two distinct cardinal teeth, of which the anterior is bifid; the posterior lateral tooth is traceable, but rather distantly placed, the anterior lateral is obsolete. The more rounded and shorter form readily distinguishes this species from *Tell. Arcotensis*, and the less distinct posterior ridge and more oval shape of the shell appears to agree with some recent species, like *Tell. coccinea*, which have been referred to the sub-genus *Tellinides*.

Locality.—Comarapolliam, in a greyish conglomeratic sandstone.

Formation.—Arrialoore group.

✓ 5. TELLINA [ARCOPAGIA] MENDOSA, *Stoliczka*, Pl. IV, Fig. 9.

Tell. testa oblonga, sub-compressa, fere æquilaterali, antice late rotundata postice angulata, plicatura parva instructa; marginibus superioribus declivis, prope rectis; margine inferiori convexo, postice flexuoso, insinuato. Cardo in utraque valva duobus dentibus obliquis cardinalibus, in valva dextra duobus lateralibus crassis instructus: anteriori dentibus cardinalibus approximato, posteriori remoto; impressionibus muscularibus magnis, elongatis; sinu pallii lato, ad $\frac{2}{3}$ totius testæ longitudinis extenso, vix ascendente.

Although the single specimen figured is only a cast, its form and otherwise very good preservation makes the shell so characteristic that it could not easily be mistaken for another species. The form is broadly oblong, about $\frac{1}{5}$ th longer than high; the valves are somewhat convex, the beaks prominent, with the sides almost straight, sloping and forming an angle of 114 degrees; the anterior side is broadly rounded, the posterior angulated, somewhat flexuous, there being an indication of a small posterior plicature. There are two cardinal teeth in each valve, and in the right two very strong lamellar teeth, of which the anterior is thick and close to the cardinals, the posterior thin, lamellar, and remote; no trace of lateral teeth is perceptible in the left valve. The muscular impressions are much elongated; the pallial sinus deep, reaching to about $\frac{2}{3}$ ds of the length of the shell and scarcely ascending at all. On the anterior slope of the cast there are a few corrugations, and, judging from the strong impressions of the different parts, the shell must have been rather solid, and, on the whole, very much like the recent *Tell. discus*. There is no trace of lateral teeth perceptible in the left valve, but such is nearly the case in some specimens of *T. discus* also; the form and position of the other teeth is, however, so very characteristic that I think there can be little doubt of our species also belonging to the sub-genus *Arcopagia*, though the pallial

sinus is in the fossil form smaller than in any recent species of that group which I have examined.

Locality.—Odium, in a brownish earthy limestone.

Formation.—Ootatoor group.

✓ 6. TELLINA [ARCOPAGIA] DISCITES, *Stoliczka*, Pl. IV, Fig. 15.

Tell. testa subdiscoidea, parvula, solidula, concentrice minute striata, æquilaterali, antice ac postice rotundata, marginibus superioribus ad apicem angulum 116° formantibus; dentibus cardinalibus in valva dextra distinctis.

A small species, but very distinct from any of the other cretaceous *Tellinæ*; the disciform almost quite equilateral shape and the strong development of the lateral teeth entirely agrees with the sub-genus *Arcopagia*. It is not very probable that the specimen figured is a very young shell, for it is of rather a solid structure. The upper sloping lateral margins form an angle of about 116 degrees, the anterior and posterior ends being both rounded.

Locality.—Moraviatoor, in a dark-brown earthy limestone.

Formation.—Ootatoor group.

✓ 7. TELLINA [TELLINIDES] ADPRESSA, *Stoliczka*, Pl. IV, Fig. 14.

Tell. testa ovato-elongata, pertenui, valde compressa, fere æquilaterali, ad utramque extremitatem late rotundata; umbonibus paululum prominulis, marginibus superioribus parumper descendentibus; superficie minutissime concentrice striata. Cardo in valva dextra dentibus duobus cardinalibus, anteriore bifido instructus; dente laterali antico distincto, postico fere obsoleto. Altitudo: longit.=0.68.

This is a remarkably compressed and very thin shell; it is almost equilateral, equally broadly rounded at both ends, and there is no trace of a posterior ridge observable; the upper margins are very little descending, the beaks being minute; the surface is covered with very fine and numerous concentric striæ. The hinge of the right valve is composed of two cardinal teeth, of which the anterior one is bifid; the anterior lateral is distinct, but the posterior almost obsolete (it is too strongly represented in fig. 14*b*). The proportion of height to length is 0.68.

Var.—*altitudine testæ: longit.* 0.60, pl. xvi, fig. 25; *testa margine inferiori ad medium parumper insinuato instructa.*

This form appears to be only a variety of the former, at least the only specimen found at present does not allow of any better conclusion. The shell is slightly more elongated, and the upper margin slopes under an angle of about 142 degrees; structure and striation of the surface is equally fine and quite similar to the former. There is a very shallow conspicuous depression running from the beak to the inferior margin, and this very much resembles some *Psammotææ*, and is the principal character which gives the shell a somewhat different aspect from the one above

described; however, the surface of this latter shell had greatly suffered in preparing the hinge line, and a very close comparison is now not easily made out. Both forms were found at the same locality and in the same rock.

Locality.—Moraviatoor, in brown earthy limestone.

Formation.—Ootatoor group.

✓ 8. *TELLINA* [*PALÆOMÆRA*] *INCONSPICUA*, *Sowerby*, Pl. IV, Figs. 6—8.

1846. *Psammobia? inconspicua*, Sow., apud Forbes, Trans., Geol. Soc., London, vii, p. 142, pl. xv, fig. 18.

1847. ? *Tellina Grangei*, d'Orb., Voy. Astrolabe, Palæont., pl. v, figs. 8-10.

Tell. testa ovata, compressa, sub-æquilaterali, parte antica longiori, paulo angustata, ad terminationem rotundata, parte postica breviori, late ac rotundate truncata; marginibus superioribus declivis, angulum 140° formantibus, margine inferiori lente curvato; superficie striis concentricis incrementi instructis; plicatura posteriori sub-obsoleta. Cardo valvæ dextræ dente unico bifido elongato anteriori instructus; dentibus lateralibus in utraque valva duobus, in valva dextra fortioribus quam in v. sinistra; sinu pallii profundo, lato, ascendente, ad terminationem uniforme rotundato.

This is a very characteristic form, and the second species of true *Palæomæra*. The shell is transversally elongated, rather compressed, inequivalve, the anterior part being somewhat longer than the posterior, though in some specimens the difference is less conspicuous than in others. The anterior end is narrowly rounded, the posterior rather broadly truncated. The surface of the valves is finely concentrically striated. The lateral teeth are stronger in the right than in the left valve, and of the cardinals I have only observed the long bifid tooth in the right valve.

The more regular wedge-shaped form and the almost total want of the posterior plicature readily distinguish the present species from *Pal. strigata*, Goldf. D'Orbigny identifies his *Tellina Grangei* with this species, but I have some doubt that the identification is correct. D'Orbigny's form is in some respect allied to our variety of *T. adpressa*, but is considerably more inequilateral. I have seen d'Orbigny's original in the Jardin des plantes at Paris, but the shell is so small and indistinct that, I confess, I am not acquainted with any of our Indian *Tellinæ* which I could confidently identify with it, and if the very young shell from which d'Orbigny has described his species be really the same as *P. inconspicua*, it would show that the posterior end becomes less distinctly ridged with advancing age.

Localities.—Alundanapooram and Serdamungalum, in whitish calcareous and bluish sandstone.

Formation.—Trichinopoly group.

✓ 9. TELLINA [ANGULUS] UNDATA, *Stoliczka*, Pl. V, Fig. 3.

Tell. ovato-elongata, solidula, convexiuscula inæquilaterali, parte antica multo breviori, late rotundata, parte postica producta, flexuose attenuata ac plicatura distincta instructa; umbonibus incurvis, acutatis; margine antero-superiori brevifere recto, postico lente curvato. Cardo in valva sinistra dente uno cardinali crassiusculo, altero (antico) tenui, paululum prominulo instructus; dentibus lateralibus elongatis; superficie concentrice obsolete striata.

Shell ovately elongated, rather thick, somewhat convex, inequilateral, the anterior side is only about $\frac{1}{5}$ th of the total length of the shell, broadly rounded, the posterior attenuated, obtusely angulated and distinctly ridged; the beaks are prominent, incurved towards the front; the upper anterior margin is nearly straight, the posterior much longer and slightly curved; both meet at the beaks with an angle of about 114 degrees. The surface is obsoletely concentrically striated, a rather unusual appearance in *Tellina*.

I have seen only two left valves of this species; in both the middle cardinal tooth is strong, the other cardinal tooth in front of it thin and very slightly prominent; the laterals are elongated, and almost throughout of the same thickness. The peculiar convex form and solidity of the shell are very characteristic of this species.

Locality.—Comarapolliam, in whitish sandstone.

Formation.—Arrialoor group.

✓ 10. TELLINA [LINEARIA?] SEMISCULPTA, *Stoliczka*, Pl. V, Fig. 5.

T. (Lin.) testa late subtrigona, valde compressa, fere æquilaterali, antice ac postice rotundata, polita, concentrice crassiuscule striata, et in dimidio antico radiatim costulata; umbone paulo prominulo antice versus incurvo; marginibus superioribus angulum 130° formantibus, margine inferiori levissime curvato.

The sculpture of the only specimen is so very characteristic that this species, though only known from a single imperfect specimen, can be readily distinguished from any other shell found in our South Indian cretaceous deposits. The whole of the anterior half is ornamented with flat radiating ribs, and the entire surface besides covered with concentric striæ, being rather strong as compared with the size of the shell. The hinge could not be exposed on account of the very thin structure of the shell.

Locality.—Serdamungalum, in a brownish calcareous sandstone; the species appears to be very rare.

Formation.—Trichinopoly group.

✓ 11. TELLINA [LINEARIA] SCULPTILIS, *Stoliczka*, Pl. V, Figs. 6-7.

Tell. (Lin.) testa ovato-elongata, sub-inæquilaterali, antice paulo longiori, ad terminationem late rotundata, postice breviori, paululum angustiori ac rotundate truncata, mediocriter convexiuscula, concentrice confertim costulata ad utrumque latus striis nonnullis radiantibus ornata, striis anticis crassiusculis; umbonibus antice versus incurvis, prominulis; marginibus superioribus moderate declivis, margine inferiori lente curvato.

This species is as to form closely allied to two others from cretaceous rocks, *Lin. concentrica*, Reuss, and *Lin. semiradiata*, d'Orb. The first has the anterior side narrower instead of the posterior, and the second has distinct radiating lines only on the posterior side; thus the form, as above described, and the numerous striæ are characteristic distinctions of the Indian fossil. The concentric striæ or ribs are rather strong, but very close together, and even on the middle portion of the surface of the shell there are some indications of fine radiating lines. The right valve has an anterior cardinal tooth distinctly bifid, and a posterior, parallel to the margin, prolonged; the lateral teeth are distant and very distinct.

Locality.—Comarapolliam, in a greyish sandstone.

Formation.—Arrialoor group.

XII. Family,—DONACIDÆ.

Animals closely resembling those of the *TELLINIDÆ*, but the siphons usually are shorter, thicker, and with fringed orifices; the foot is lingui-form, compressed, the palpi and gills of moderate size, one pair on each side.

The shells are more or less wedge-shaped, transversally elongated, always strong and solid, closed on both ends, the posterior side often shorter, but some species are nearly equilateral, and a few others have the anterior side shorter; the inner margin of the shell is smooth or crenulated; the hinge usually has two strong cardinal teeth in the left and one in the right valve; sometimes there is in the latter a small posterior cardinal tooth traceable; lateral teeth are two in each valve, those of the left are always smaller than the corresponding ones of the right valve, sometimes those in the left valve altogether disappear, but the right laterals very rarely become obsolete; the muscular impressions are strong and the pallial sinus deep, extending in the elongated forms like *Hecuba*, or *Iphigenia*, horizontally, in *Donax* and others it is ascending and dilatated; ligament short, strong, generally supported by thickened fulcra.

Deshayes was the first to point out some of the characteristic distinctions in the animals and shells of the *DONACIDÆ* and *TELLINIDÆ*, urging their separation as two distinct families respectively. Formerly the genus *Donax* was classed with *Tellina*. H. and A. Adams and others formed a sub-family under the name of *DONACINÆ*, and there can be no doubt that the latter are very closely allied to the *TELLINIDÆ*, which is especially the case with regard to some of the forms

of *Iphigenia*, and others, possessing a thin shell. It is in fact by no means certain that a thorough examination of the animals of the various forms of *Donax* and *Tellina* will greatly support a separation into two families, although the typical *Tellinæ* and *Donaces* are apparently more distinct than is *Scrobicularia* for instance from *Gastrana*. With respect to form and structure of the shells we see that the *TELLINIDÆ* are analogous to the *SCROBICULARIIDÆ*, while, as already mentioned, the *DONACIDÆ* exhibit a similar relation to the *PAPHIIDÆ*. On the other hand, the *DONACIDÆ* form a good connecting link between the *TELLINACEA* and the *VENERACEA*, so much so that several authors like Philippi and others consider it more correct to class *Venus* and allied genera in the family *TELLINIDÆ*; this is, however, for reasons which I have already (p. 103) stated, by no means justifiable. The following recent and fossil genera and sub-genera may be conveniently distinguished.

1. *Tancredia*, Lycett, 1850, (*Hettangia*, Terquem, 1850, see Morris and Lycett, Mollusca of the Great Ool., Palæont. Soc., London, 1853, pt. II, p. 90). Shell equivalve, sub-equilateral, anterior side usually somewhat produced, narrowly rounded at the extremity, posterior side shorter, generally sloping and obliquely truncated, ligament short, external; hinge with one or two cardinal teeth in each valve, a small anterior in the right and a similar posterior in the left valve being sometimes developed; lateral teeth two in each valve, approximate to the cardinals, and usually stronger in the right than in the left valve; muscular impressions oval, pallial line simple.

This is, as far as I know, the oldest form which certainly belongs to the family *DONACIDÆ*. The resemblance is indeed so great, that it is almost difficult to distinguish the fossil *Tancrediæ* from some *Donaces* and *Iphigeniæ*. As regards form they resemble both, but as regards dentition they are more allied to *Iphigenia*, there being either one or two unequal cardinal teeth in each valve. *Tancredia* is said, however, to possess an entire pallial impression, which is rather remarkable and not to be met with in any of the recent species of *DONACIDÆ*, though it is very small in some belonging to *Galatea*.

Species of *Tancredia* are described from the Lias, Dogger, and Malm; one species, *T. americana*, is also noticed from American cretaceous deposits; but it is very probable that some of the triassic and rhætic forms have also to be referred to that genus. Meek in his Check list of cretaceous North American fossils proposes for *Tancredia* a special family which seems to me perfectly unnecessary. For the various forms of typical *MYACEA*, some of which have a sinuated and others an entire pallial impression, sufficiently show that we cannot lay too much stress upon that character.

2. *Isodonta*, Buvignier, 1852, (Statistique Geol. de la Meuse, p. ii;= ? *Sowerbya*, d'Orb.). Shell equivalve, sub-equilateral, solid, right valve with two almost horizontally diverging cardinal teeth, left valve with one central cardinal tooth, two lateral teeth in each valve much stronger in the right than in the left valve. *Isodonta Deshayesea*, Buv., from the Oxford clay, is the type of the genus.

Lycett (Suppl. Monog. on the Moll. from the Great Oolite, Palæont. Soc., London, 1863, p. 65,) describes several species of this genus, adopting for them d'Orbigny's name *Sowerbya*, as a synonym of *Isodonta*. D'Orbigny (Prod. I, p. 363,) suggested this name for a jurassic species, *S. crassa*, of which he says that it possesses a cartilage-pit. Lycett suggests that that author had likely seen only the right valve and took the median pit, which corresponds to the tooth of the left valve, as a cartilage-pit, believing, therefore, that the genus was allied to *Mactra*. This may be, and probably is, the case, but as neither d'Orbigny nor, as far as I know, any subsequent author had as yet given a description and figure of the type species, it is impossible to accept his name in preference to, and as a substitute for, *Isodonta*. It may after all turn out to be something else, and it is far preferable to keep such uncertainties out of our lists. No other but jurassic species of *Isodonta* have been described, and they are few in number. The strongly developed hinge-teeth and their arrangements readily distinguish that genus from *Tancredia*.

3. *Egerella*, Stoliczka, 1870, (*Egeria*, Lea, 1833, Contrib. to Geology, p. 49, non *idem* Roissy or Leach). Shell elongated, sub-trigonal, anterior side much shorter than the posterior; hinge with two cardinal teeth in each valve, one of which is bifid, lateral teeth none, sometimes they are indicated by a thickening of the margins; ligament external, apparently on the shorter side, inner edge of shell occasionally crenated.

Lea described several somewhat different species under this genus. Conrad referred the orbicular forms to *Mysia* and *Sphærella*, and they certainly belong to the *LUCINIDÆ*, reserving the name *Egeria* for such forms as *Eg. subtrigona* and *ovalis* of Lea. These shells externally very much resemble the sub-genus *Mæra* of *Tellina*, but as the latter never have the inner margin crenated, it is probable that the present classification of the genus is the more correct one. Conrad in his Check list of eocene N. American fossils (1866) refers seven species to the genus. Deshayes and others describe similar tertiary forms, but we must yet wait for a better characteristic in order to be able to distinguish the genus sufficiently from *Donax* and several of its sub-genera.

4. *Donax*, Linné, 1758. Shell ovately elongated, anterior side usually the longer, wedge-shaped, rounded at the end, posterior shorter, obliquely truncated, surface variously striated and covered with an epidermis; hinge with two cardinal teeth in the left and one in the right valve, lateral teeth stronger in the right than in the left; pallial sinus deep, broad and somewhat ascending; inner edge of shell smooth or crenulated.

The genus *Donax* has been restricted by H. and A. Adams for the species of the type of *D. rugosus*, Linn., while some other forms resembling *compressus* have been placed by the same authors in the sub-genus *Latona* of Schuhmacher. I confess that I am unable to find even a sub-generic distinction of any value between the two divisions; a few of the other sub-genera are, however, more easily definable. Some of the species like *D. vittatus* ought to be referred to *Serrula*.

Again, some of the fossil species in form resembling *Donax* have been called by palæontologists *Donacites*, but the name cannot with our present knowledge of the respective shells be allowed to have any signification in conchological literature.

4a. *Serrula*, Chemnitz, ? Shell elongated, sub-equilateral, anterior side inflated, somewhat flexuous, rounded, posterior equally or slightly less produced, sub-compressed, with a rounded plicature, angularly rounded at the end; fulcra not very prominent; surface concentrically and partially radiately finely striated. The well known European *D. trunculus*, Linné, may be considered as the type of this sub-genus. Some of the species like *D. naviculus* or *gracilis* appear to be more brackish forms and in form and dentition allied to *Iphigenia*. The lateral teeth are small in the right valve and obsolete in left; there is besides a small anterior cardinal in the right valve, not usually noticed in other forms of typical marine *Serrulæ*.

4b. *Heterodonax*, Mörch, 185? Shell broadly triangular, somewhat rounded, sub-compressed, smooth, covered with epidermis; hinge-teeth distinct in both valves. Deshayes' *D. ovalinus* is the most characteristic form of this sub-genus.

4c. *Capsella*, Gray, 1854 (?) Shell very much elongated, posterior side much shorter, oblique, with a rather sharp plicature, sub-angular at the end; surface covered with a thin epidermis. *D. acutangulus*, Desh., is about the most typical form of this group.

4d. *Hecuba*, Schuhm., 1817. Shell sub-triangular, sub-equivalve, anterior end narrowly rounded, posterior more or less produced, concave at the upper marginal slope, supplied with a very sharp plicature, angular at the end; lateral teeth strong in both valves, and besides that the right valve has near the anterior end of the slope a marginal groove, in which fits the corresponding edge of the left valve. The best known species of the present type is *D. scortum*, Linn.; it represents a better marked sub-division than any of the other sub-genera.

5. *Iphigenia*, Schuhm., 1817. Shell elongated, of tellinoid form, but rather inflated; hinge with two cardinals in each valve, the anterior in the right the smallest, lateral teeth obsolete or nearly so; sometimes indicated in the left valve; pallial sinus deep. The species of *Iphigenia* are estuary shells, covered with a greenish epidermis; they are at present only known from America and the Senegal, but one species, and this a very large one, certainly occurs in the Ganges delta. They form a natural passage from most of the marine *Donaces* to the more brackish or fresh water types which follow next. Chenu accepts for these shells Lamarck's name *Capsa*, quoting at the same time after d'Orbigny some fossil forms which have nothing at all to do with this genus, Deshayes as well as d'Orbigny having taken the name *Capsa* in a totally different sense from Chenu.

6. *Fischeria*, Bernardi, 1860, (Monog. des genres *Galatea* et *Fischeria*, Paris). Shell broadly triangular, rather high, covered with epidermis; hinge with two cardinals in each valve, the posterior one in the right valve small, marginal; two small laminar, lateral teeth in the right valve; pallial sinus deep.

Bernardi describes one species, *F. Delesserti*, from the rivers of Guinea. Its form and general character is said to be intermediate between *Iphigenia* and *Cyrena*, differing from the latter by its pallial sinus and the smaller number of hinge-teeth. *F. curta*, Dunker, also from Eastern Africa, is a second species.

7. *Galatea*, Brug., 179? Shell sub-trigonal, thick, covered with a strong horny epidermis; hinge with two cardinal teeth in the right and three in the left valve, all much elongated, lateral teeth two in each valve, pallial sinus deep. The species are from the Nile and the rivers of Western Africa. Bernardi examined the animal, and he states that it is more allied to *Donax* than to *Cyrena*. T. Prime gives a list of thirteen species of *Galatea* (*vide* Proc. Acad. Nat. Sc., Phil., 1861, p. 25).

Deshayes suggests that *Sunetta* = *Meroe* also probably belongs to the *DONACIDÆ*. There is no doubt that if we compare the general character of the shell of such species as *S. Solandri*, Gray, with its thick olivaceous epidermis, we are strongly reminded of its great similarity with *Iphigenia*, but in this as in all other species of *Sunetta* the hinge possesses three cardinal teeth in each valve and one anterior lateral. Such arrangement entirely agrees with typical *VENERIDÆ*, and I would, therefore, prefer, from analogy of the shells, the classification of *Sunetta* next to the fossil *Grateloupia*. I hope shortly to be able to return to this question, as soon as I shall have an opportunity of examining the animals of some of our eastern species, for up to the present time the animal of *Sunetta* is not known. A peculiar form of *Sunetta* identical or very similar to *Solandri*, Gray, appears to be common on the Bombay coast.

I have already remarked that the first forms allied to *DONACIDÆ* appear in the Trias; there are at least no species from palæozoic rocks which, even from external resemblance, could be referred to that family. In the Lias we have full evidence of the occurrence of *Tancredia* (or *Hettangia*); and next comes *Isodonta* from jurassic beds; true *Donaces* first appear in the cretaceous period, and their number very gradually and sparingly increases until the present time at which the family obtains the greatest development. Sowerby, in his most recent monograph of the genus *Donax* (Thesaur. iii), describes 65 species; including those of the other genera and later additions, there are about one hundred species known, distributed all over the temperate and tropical seas, being, however, as usually, more numerous in the latter. Of the tertiary species there are no more than about 22 species on record, and of these the larger number belongs to the eocene fauna of the Paris basin, if really all the species prove to be distinct.

From cretaceous rocks I have but little to mention besides the *Tancredia americana*, M. and Hayd., already alluded to. M. Coquand (Pal. de Const., pl. vi, fig. 18,) described a species as *D. Loryi*; the shell may belong to the sub-genus *Capsella*, Gray, but it may equally well be a *Mæra* (*TELLINIDÆ*), or even a *Saxicava*. Gabb describes *Donax latus* from the Tejon group of California, (Pal. Calif. ii, p. 183, &c.). Other species noted as *Donax* from cretaceous rocks have been shown to belong to different genera. I am acquainted with a single specimen from our South Indian cretaceous rocks; it appears to be a true *Donax*.

DONAX, *Linné*, 1758.DONAX, *sp. ind.*, Pl. V, Fig. 4.

I have figured this form simply to draw attention to this very interesting species, apparently the first occurrence of a true *Donax* in the eastern cretaceous deposits. The form of the right valve (the only one found) entirely agrees with typical *Donaces*, except that it is somewhat more convex than most other allied forms are. The specimen is only a cast, but the impression of the cardinal, a strong anterior and a small approximate posterior lateral tooth, are distinctly traceable. It could be suggested that the shell was a *Tellina*, there being some such similar forms belonging to *Mæra* and also to *Macoma*, but the very strong marginal impressions of the shell clearly indicate its solid structure, such as we find to be characteristic in *Donax*. It is to be hoped that further researches will be successful in procuring better materials from which the species may be sufficiently characterized.

Locality.—South-east of Parchairy, in a brownish calcareous sandstone.

Formation.—Trichinopoly group.

IV. Order. VENERACEA.

Taking the family *VENERIDÆ* as including the most typical forms of this order, the animals are characterized by an oblong, moderately thick form with the mantle margins widely open in front, and posteriorly with two separated, moderately elongated, siphons; the foot is generally large, laterally compressed, sometimes (*CARDIIDÆ*) rounded near the base, often with a byssal groove, but rarely with the byssus developed, pointed at the end; there is one pair of elongated gills on either side of the body, and the labial palps are large and sub-trigonal.

The shells are oblong, generally longer than high, sometimes rounded, mostly closed in front, slightly gaping posteriorly, solid and covered with a thin deciduous epidermis. The hinge is composed of two or more cardinal teeth in each valve, either fitting one beside the other or crossing each other; lateral teeth are often present. The muscular impressions are generally well marked, oval, slightly impressed, the pallial line slightly sinuated, or entire; the ligament is always external.

The families belonging to this order are five; the *PETRICOLIDÆ*, *VENERIDÆ*, *GLOSSIDÆ*, *CYRENIDÆ*, and *CARDIIDÆ*. This arrangement is considerably different from that, for instance, adopted in H. and A. Adam's "Genera."

Those authors associated with the first named family the *GLAUCONOMYIDÆ* which I have placed in the *MYACEA*, stating the reasons for that transfer (see p. 89). The *VENERIDÆ* are divided into four sub-families, *TAPESINÆ*, *VENERINÆ*, *SUNETTINÆ*, and *DOSINIINÆ*, the first of which I consider to be the nearest allies to the *PETRICOLIDÆ*. The family *GLOSSIDÆ* has been made to include besides *Glossus* (= *Isocardia*, Lam.,) *Trapezium*, *Coralliophaga*, and several other allied genera which were formerly referred to the *TAPESINÆ*, also *Cyprina* and its allies for which H. and A. Adams

adopted a special family. The study of the very numerous fossil forms has, I think, fairly established the propriety of this altered classification. H. and A. Adams' *CYRENOIDEIDÆ*, proposed for the genus *Cyrenoidea*, Jonas, do not belong, I believe, to this order, but to the *LUCINACEA*.

Looking upon the relations which the present order offers, as compared with the previous one, we have in the family *PETRICOLIDÆ* a good connecting link. They mostly have the united mantle margins and a rather small somewhat digitiform foot similar to that of the *MYACEA*, while they partially possess the prolonged divided siphons of the *TELLINACEA*; their burrowing habits recall the *PHOLADACEA*, but the general character of organisation of the animals as to the division of the siphons, the form of the gills and of the palpi, and the hinge of the shell, is that peculiar to the *VENERACEA* in general. Similar repetitions of the characters of previous orders are met with in other families. Thus, for instance, do the *DOSINIINÆ* represent, strictly speaking, quite a peculiar type of shells, combining various characters. Some of them have the siphons elongated and united, like the *MYIDÆ*, but a thick crescent foot such as we only find again in the *ERICINIDÆ*; the shells often have great affinities to the *TELLINIDÆ* in the form and distribution of the hinge-teeth as well as in the form of the pallial sinus.

The *GLOSSIDÆ*, in part, and also the *CARDIIDÆ*, appear to form in the arrangement of the hinge-teeth transitions from the *VENERACEA* to the *CHAMACEA*. In the former family the hinge-teeth are, namely, often placed parallel to the hinge margin, which is one of the principal characters of *Chama*, while in the *CARDIIDÆ* the cardinal teeth cross each other, which does not occur in any other family; but in some of the more elongated species, particularly those living in fresh and brackish waters (*Lymnocardium*) the transmutations from the ordinary arrangement of the teeth in the *VENERIDÆ* can clearly be traced to that of the typical *CARDIIDÆ*. Thus, on the whole, all the different genera appear to form a natural order belonging to one type of shells.

In a palæontological point of view the *VENERACEA* are of very great importance, and many species characteristic for different strata belong to this order. When compared, however, with the *MYACEA*, they may be said to belong to a more recent period. The *Myæ* and their allies seem to have their greatest development in the lower mesozoic epoch, the *CHAMACEA* in the middle and upper mesozoic, the *VENERACEA* in this last and in the lower cainozoic, the *TELLINACEA* in the cainozoic and recent, and the *PHOLADACEA* in the recent epoch. At the same time forms belonging to the *VENERACEA* are not absent in older formations. Some species of *PETRICOLIDÆ*, *GLOSSIDÆ*, and probably also of the *CARDIIDÆ* are to be met with already in palæozoic rocks, and from that time their number gradually increases until the present epoch. The *VENERIDÆ* do not make their appearance much before the cretaceous period, and the *CYRENIDÆ* are found at the base of that period in brackish and fresh-water deposits.

XIII. *Family*,—*PETRICOLIDÆ*.

(LITHOPHAGA, Lamck. et auctorum).

The animals have a more or less prolonged, thin, sub-cylindrical foot, generally provided with a byssal groove, the byssus itself being, however, sometimes rudimentary, sometimes obsolete; the mantle margins are united along the greater part of the ventral side; they are thickened and reflected over the edges; the siphons are for a shorter or greater distance from the base united, but separated towards the end, and each of the orifices is fringed; one pair of gills exists on each side; they vary in size, as do also the palpi, the length and height of which still more depend upon the size of the animal than the corresponding dimensions of the gills.

The shells are solid, compressed, or more or less inflated, slightly gaping in front and more widely behind; they usually burrow in stones, very rarely in loose sand; the valves are inequilateral, sometimes unequal, and occasionally covered with a horny epidermis; hinge small, with two or three cardinal teeth in each valve; no lateral teeth are present; ligament external; pallial sinus deep and always well developed.

The nature of the habitat of these shells is the cause of considerable variation as regards their shape, so much so that it is often almost impossible to determine its limits among a large number of specimens evidently belonging to the same species. I have already stated my reasons for treating the present family at the head of the whole order (see p. 136).

The genera referable to it are *Petricolaria*, *Petricola*, *Choristodon*, *Saxidomus*, *Rupellaria* (as emended), and *Venerupis*. In placing the last genus in this family, I follow the classification proposed by Deshayes; and there can be no doubt that in habits, as well as in the organisation of the animals and shells, this classification is preferable to that in the *TAPESINÆ*; I shall again allude to this point when speaking of this last sub-family. Fischer (Jour. de Conch., vol. v, 1856, p. 324,) says that *Narario* ought to be classed next to *Choristodon*, and H. and A. Adams consider both genera as identical; but I have already remarked (p. 91) that, judging from the figure in the Proceedings of the Zool. Soc. for 1863, there appears to be a strong relation between that genus and *Clementia*, as well as the fossil *Psathura* of Deshayes. The study of the anatomy of *Clementia* must now show what position in the system it ought to take; it either belongs, with *Narario* and allied forms, to the present family, or to the *DOSINIINÆ*, or to the family *GLAUCONOMYIDÆ*. Weinkauff, (Conch. des Mittelmeeres, vol. i, p. 94,) describes with *Petricola* and others also *Lucinopsis*, *Cypricardia*, and even *Cyamium* in one family which he calls *LITHOPHAGA* after Lamarck.

In a fossil state there are not many species of *PETRICOLIDÆ* known. Some forms, similar to *Petricola*, already occur in the trias, a few were described from the jura, but only in the cretaceous deposits do we meet the first satisfactorily

determined species. They gradually increase in the tertiaries and attain their maximum of development in the present seas. About 70 species are known recent, and when the rocks and coral reefs, as, for instance, those of our eastern seas, have been more assiduously searched large additions may be expected. Their distribution is very large; with the exception of the arctic seas, they occur almost everywhere, especially, however, where coral reefs are to be found.

1. *Petricola*, Lamarck, 1801. Shell oviform, or sub-cylindrical, produced posteriorly and more widely gaping than anteriorly, sometimes with unequal valves, the right one being larger and reaching with the edges over the left one all round; surface radiately and concentrically finely ribbed, and often lamellar, usually covered with a thickened epidermis; hinge with two cardinal teeth in each valve; sometimes the posterior cardinal of the left, or the anterior of the right valve become obsolete; or in very aged specimens all the hinge-teeth disappear, as they do, for instance, in *Saxicava*; again, in others there is in the left valve a distinct indication of a third posterior tooth, and an additional anterior tooth in the right valve is also indicated.

There are two different types of shells classed under the genus *Petricola*. The one,—and for these the name *Petricola* ought to be reserved,—are represented by *P. lithophaga*, Retz.; they have an oval shape, are thick anteriorly, attenuated posteriorly, more or less globose, solid, with the hinge-teeth usually short and thick. The pallial sinus varies, being either wide and obtuse (as in the type species) or angular (as in *P. monstrosa*).

The miocene shell which Conrad (Proc. Phil. Acad., 1862, p. 576,) introduces as *Pliorytis centenaria* (*Petricola*, olim) in the family *PETRICOLIDÆ* is to all appearance a *Capsa* (*Asaphis*).

1a. *Petricolaria*, Stol., 1870. The second group is represented by *Pet. pholadiformis*. In this the shell is very much elongated, sub-cylindrical, the sinus narrow and very deep; the hinge has two teeth in each valve, attached below the hinge area and curving upwards; in the right valve the anterior tooth is hook-like, the posterior much larger, broadly laminar and bipartite; in the left the anterior is very large and bipartite, its anterior portion almost representing a separate hook-like tooth corresponding to the anterior tooth of the right valve, the posterior portion is thick and prominent and longitudinally grooved; besides this there is a small, sometimes obsolete posterior cardinal tooth. Although there exists a decided similarity between the hinge of *Petricola* and *Petricolaria*, there is a very marked distinction between them. Fischer examined the animal of *Pet. denticulata*, Hanley, and he records (Jour. de Conch., vol. v, p. 326,) several important distinctions in the elongated form of the palps, gills, &c., as compared with those of *Petricola* proper, but he is inclined (ibid p. 329) to consider these as variations of one and the same type. No doubt such is and must be the case in all other families also, but at the same time the distinctions pointed out appear to me to be in favor of a separate (at least sub-generic) grouping of these forms. I may add that there is

strong geological evidence for the separation into two genera, for while we meet with typical *Petricolæ* already in the cretaceous (and probably jurassic) period, we only find *Petricolaria* in recent or in sub-recent deposits.

2. *Choristodon*, Jonas, 1844. Shell ovate, tumid, truncate behind, rather solid, with a rugously striated surface generally covered by a calcareous coating; valves nearly quite closed; hinge, strictly speaking, with three cardinal teeth in each valve; in the right the two anterior are distinct, the posterior is represented by a low ridge only; in the left the middle tooth is thick and bifurcated; the two others very small and often almost obsolete; muscular impressions large, pallial sinus deep, broad and obtuse.

Fischer (Jour. de Conch., vol. v, p. 323, &c.) carefully examined and compared the animal and shell of *Choristodon*, of which *Ch. divaricatum*, Chem., is the type, with those of *Petricola*, and he considers the distinction between both to be a generic one. With regard to the animal the very small size of the palpi of *Choristodon* is especially noticeable as compared with that of *Petricola*. Fossil species which in general form quite resemble the present genus already occur in cretaceous rocks.

3. *Saxidomus*, Conrad, 1837. Shell ovate, ventricose, solid; lunule and area indistinct; hinge with three to four cardinal teeth, the latter number occasionally occurs in the right valve; muscular impressions large, pallial sinus deep, horizontally extending. The species of *Saxidomus* mostly are from the American seas, few in number, and, strictly speaking, they are only a sub-division of *Venerupis*.

4. *Rupellaria*, Fl. de Bell., 1802. Shell elongated, moderately tumid, surface rugously striated and ribbed, distinctly gaping posteriorly; hinge in the right valve with two cardinal teeth, and a third very small, but usually obsolete, anterior; the middle one is prominent, curved as in *Petricola*; the posterior is longitudinally laminar, low and bifurcate; in the left valve are three distant and very unequal cardinal teeth; the middle one is similarly projecting as the corresponding tooth in the other valve. *Rup. lamellifera*, Conrad, may be considered as the type of the genus. Deshayes (Paris foss., 2nd edit., p. 402,) says that the name *Rupellaria* was applied by Fleuriau de Bellevue to a species of *Petricola* and not a *Venerupis*. As the type of the last genus is well known, and as there have been unquestionable differences pointed out between Fl. de Bellevue's *Rupellaria* and true *Petricola*, it seems probable that that author had under view one of the shells for which the former name may be restricted. I am sorry to say that Fleuriau's opuscle is at present inaccessible to me, but even should my supposition not be entirely supported by the facts, I still believe that the former name can be secured with advantage for those *Petricola*-like forms of *Venerupis*. There can be little doubt that the generic separation from *Venerupis* has a good ground; the hinge as compared with that of the compressed true *Venerupis* is really very different, more like that of *Saxidomus* and *Petricola*, and equally distinct also is the shape of the shell, as I shall presently indicate more clearly.

5. *Venerupis*, Lamarck, 1818. Shell sub-quadrangular, more or less laterally compressed, posteriorly often somewhat dilatated and gaping; surface radiately ribbed, and at least towards the posterior end laminar; hinge with three usually distinct sub-equal teeth in each valve, the middle teeth generally are the strongest and furrowed; the anterior tooth of the right valve usually is the smallest, but it very rarely becomes obsolete. Lamarck's *Donax irus*, Linn., is the type of the genus.

The hinge-teeth of *Venerupis* are very distinct from those of *Rupellaria* as restricted; they are sub-equal, close together and diverging, exactly similar to those of *Tapes*. This form of the hinge-teeth is observable even in those species which are a little ventricose and resemble *Rupellaria* in form. For this reason the genus has been classed by H. and A. Adams in the *TAPESINÆ*, but the general character and ornamentation of the shell with the overlapping margins of the mantle anteriorly, as distinctly indicated in some species, further, the rounded form of the small foot and the habitat of the shells, sufficiently indicate their close relation to *Petricola*.

LIST OF CRETACEOUS SPECIES.

With the exception of a single imperfect specimen, I am not acquainted with any species of *PETRICOLIDÆ* from the cretaceous rocks of Southern India, but a few have been described from other countries. Pictet and Campiche (Pal. Suisse, 4^{me} ser., p. 163, &c.,) quote the following:—

1-4.—*Petr. neocomiensis*, Buv., *Pet. Rhodani*, P. and R., and *Pet. Meriani*, P. and C. (both probably belonging to *Choristodon*), *Escheri*, P. and C.

Petr. nuciformis and *canaliculata* of Sowerby are justly excluded from this family altogether; the former is a *Corbis*, or some allied genus, and the latter a *Cardium*.

5-7.—*Venerupis neocomiensis*, Buv., *V. Landeroniana*, P. and C., and *V. Saxoneti*, P. and C. The two former are known only from cast specimens; the first may be a *Rupellaria*; and the last, of which Pictet and Campiche only give a short characteristic, may also belong to the same genus.

I do not know of any other species having been described since Pictet and Campiche's publication, 1865.

8.—*Choristodon*? A single specimen occurred in the white limestone of Ninnyoor. It has the general form of *Choristodon*, and traces of shell certainly indicate by their earthy and soft structure a species of this genus. The shape is quadrangularly ovate and very tumid; the surface appears to have been finely striated concentrically, and a deep ascending sinus is indicated, though not distinctly; vide pl. xvii, fig. 3.

XIV. Family,—*VENERIDÆ*.

The organisation of the animals belonging to the present family must be regarded as characteristic of all the *VENERACEA*. As a rule, the animals have an elongated or roundish oval shape, are moderately thick, have a thin mantle with thick, sometimes crenated edges, united only for a very short distance below the siphons. The gills are large, sub-angular, two on each side; the palpi generally small. The foot is stout, sometimes thick, sub-quadrangular, but usually prolonged, pointed at the end, and below sometimes furnished with a byssal groove, the byssus being, however, developed only in some of the compressed forms, like *Tapes* and

allied genera. The siphons are thick, of moderate length, united only at the base, separated for the greater part of their length and with each of the orifices fringed; sometimes they are united nearly up to the end, and in such cases the terminal orifices are not fringed.

The shells are oval or elongated, though the length very rarely exceeds double the height, except in some of the fossil forms; the structure is mostly solid and calcareous, seldom thin with a somewhat nacreous like appearance inside (*Clementia*). The hinge has, with slight modifications, generally two or three cardinal teeth in each valve, sometimes there is one additional, and at other times one or the other of the three cardinals becomes obsolete; a lunular tooth is often present, but no other very distinct lateral teeth occur; the ligament is always external, supported by strong cicatrices; the pallial sinus usually of moderate size, occasionally only indicated by the pallial impression being truncated posteriorly. The outer surface of the shell is very variable, either smooth or striated, sometimes cancellated, but rarely provided with spines. All the recent species inhabit flat shores, burrowing in sand or mud, and are, according to their habitat, covered with a thinner or thicker epidermis; as a rule, they are strictly littoral inhabitants. The geographical distribution is in other respects world-wide; the eastern, especially the Indian and Australian seas, are, however, the richest: some, like *Cytherea*, especially the *Circe* group, *Callista*, *Sunetta*, and several others, are mostly peculiar to them; others, like *Dione* and partially *Tivela*, are prevalent in the American seas; while only few comparatively, like *Dosinia*, *Caryatis*, *Gomphina*, and others, have a more uniform distribution in the eastern and western seas.

Dr. E. Römer is publishing a Monograph of the *VENERIDÆ* (under the name "genus *Venus*") with beautiful illustrations in the "Novit. Conchologicæ." The descriptions of the species of the *Cytherea* group have nearly all appeared, but lists of most of the other species of the family have already been printed in the "Malacozoologische Blätter." Dr. Pfeiffer lately also began a Monograph of the family in Martini and Chemnitz' "Conchylien-kabinet;" he has also published some preliminary remarks in Mal. Blätt. for 1868.

In a classificatory point of view the study of recent forms has an unequalled advantage over that obtained from fossil forms; and as the above-mentioned publications are now in progress, I will not encroach upon the field beyond what seems absolutely necessary for the correct (as far as possible) determination of the fossil species, particularly those occurring in cretaceous deposits. A few indications may prove useful to Dr. Römer's and Pfeiffer's work.—I cannot omit to notice the entirely unc customary arrangement which Dr. Römer is introducing by his genera, sub-genera, sections, and sub-sections, all of which he often designates with separate "generic" names, without using them in any way in his nomenclature. What use then are these names? Simply to remain to be written on labels of a carefully arranged cabinet? If they are at all useful, they must become familiar in science, and if we admit a "genus [sub-genus] species," it will probably serve all purposes of science and still not lose much of its convenience.

Considering geological history, the *Veneracea* are not very old. The first forms externally very much resembling *Cythereæ*, *Callistæ*, and *Caryates* are met with in jurassic (very seldom any in triassic) strata; *Eriphyla* (of the *DOSINIINÆ*) and perhaps *Cytherea* appear to be, however, the only genera well ascertained to occur in the lower and middle mesozoic beds. In the cretaceous period the number of species gradually increases, and many of the recent genera there make their first appearance. Their then geographical distribution, (as at present known), very slightly, however, indicates the one they now possess.—In the older tertiaries, forms of *Cytherea*, especially of *Caryatis* and *Callista*, are common, but very few of *Tivela*, and scarcely any of *Circe*, *Lioconcha*, *Venus*, *Sunetta*, &c., are to be found. On the whole, the character of the fauna is very little altered in the eocene, as compared with that of the upper cretaceous period. In the upper tertiaries, (the miocene, &c.), there is, however, a rapid change in the fauna, and, with few exceptions, the forms are the same as those living at the present day; several of the recent tropical genera and some identical species were then living in more northern European latitudes, indicating the then existing conditions of the climate and its gradual changes. I look upon the family *VENERIDÆ* as particularly interesting in this respect, and the first and great desideratum we have at present to look to is the exact study of the present habits of these aged forms, in order to be able to make correct conclusions as regards the conditions of climate and life during the middle and upper cainozoic period in Europe.

I shall now give a short account of the generic and sub-generic forms of the *VENERIDÆ*, according to their arrangement in four sub-families,—*TAPESINÆ*, *VENERINÆ*, *SUNETTINÆ*, and *DOSINIINÆ*; the first connects the family with the *PETRICOLIDÆ*, and the last indicates a good passage to the *CYPRINIDÆ*. A review of the species described from cretaceous deposits will follow the general account.

a. *Sub-family*,—*TAPESINÆ*.

The species referred to this sub-family agree with each other in several important points of their structure. The animals have a digitiform foot, gradually attenuating towards the end, which is pointed; near the lower base the byssus is generally well developed; the mantle margins are only for a short distance united below, but sometimes separated at the outer edges all round; the siphons are moderately produced, thick, united at the base, and for a short distance separated at the end, with strongly fringed margins at the orifices.

The shells exhibit a great deal of variation in their form; they are always inequilateral, the anterior side being the shorter one; their surface is either smooth, or more often concentrically elegantly ribbed, or sometimes radiately and divaricately striated; they are generally thin, and the inner margin is very rarely crenulated; the pallial sinus is of moderate size, either horizontal or ascending; the hinge is composed of three cardinal teeth in each valve; the distinctive characteristic of the teeth is, that they are always situated close together, as if radiating from one point; they

are vertically erect, laterally compressed, and generally bifid, with the exception of the most anterior tooth in the left, or sometimes in both valves: this peculiarity is indeed so characteristic as compared with the hinge of *Venus* that no doubt can be entertained in the determination of the shell; it is the most constant of all the other characters of the sub-family, and when combined with a compressed shape of the shell, as, for instance, in *V. literata*, Linn., the resemblance of such forms to *Venerupis* (of the *PETRICOLIDÆ*,) is, as already mentioned, striking. The only rather solid shells are those belonging to the type of *T. pinguis*, Chem., mostly approaching in character some species of *Meretrix*.

In 1864 Dr. Ed. Römer published in the *Malaco-zoologische Blätter* "a critical synopsis of all the species belonging to *Tapes*, a sub-genus of the genus *Venus*." The author admits four sections of *Tapes*, each under a different name. They are *Paratapes*(=*Textrix*; Röm.) *Parembola*, *Amygdala*, and *Hemitapes*. I have already recorded my opinion with regard to the propriety of the names which Dr. Römer gives to his sections or sub-sections. I have also stated that it would not be advisable to interfere with Dr. Römer's work as long as it is in progress. So far, therefore, as the recent forms are concerned, I shall restrict my remarks to a few suggestions, illustrating my ideas on the classification of the *TAPESINÆ* by quotations of well known species as types.

1. *Paratapes*, Stol., 1870, (*Textrix* apud Römer, not *idem* Blackwall or Sundewal, 1833, *Arachnoidea*). Type *P. textrix*, (Chem.). Shell much elongated, compressed, outer surface smooth.

2. *Hemitapes* apud Römer; type *Tapes pinguis*, (Chem.). Shell inflated, solid, ventricose, especially at the umbones, which are incurved, more or less narrower posteriorly; outer surface smooth.

2a. Römer refers to the above as a special section *Venus rimularis* of Lamarck, which has a rhomboidal shape and concentric sulcations. This is a somewhat different type of shell, and could be considered, moreover, as a section of *Pullastra*, or perhaps still better as distinct from both and classed with *T. denticulata*, Sow., the Californian *Tap. straminea*, &c., the shells of these species being solid, with the inner margin crenulated.

3. *Pullastra*, Sow., 1827, (as emended by H. and A. Adams). Shell elongated, moderately inflated, anterior side peculiarly narrowly rounded; surface of valves concentrically sulcated or striated; pallial sinus ascending, rather higher than in other forms of *Tapesinæ*. The type of this is *Ven. malabarica*, Chem., or *Tap. turgidula*, Desh. The species are rather numerous in our eastern seas; *Venus cor* of Sowerby from Cutch also belongs to it.

3a. A number of species which are strongly inflated, cuneiform, thick and short in front, and gradually becoming narrow towards the posterior end, thus in this respect very much resembling *Hemitapes*, appear to form a special section. Chemnitz's *Venus striata* is the most characteristic species of this group.

4. *Tapes*, Megerle, 1811, (*Parembola* apud Römer). Shell sub-rhomboidal, compressed, beaks very small, surface of shell concentrically ridged or sulcated,

pallial sinus extending horizontally, or with the point bent downwards. The type of this genus is Linné's *Venus (Tapes) literata*, and I think it quite unjustifiable to introduce another quasi-generic name for it as proposed by Römer.

4a. *Amygdala* apud Römer (*Cuneus*, da Costa, apud H. and A. Adams). Shell in form resembling *Tapes*, but the surface is radiately ribbed, and the inner edge shows sometimes indications of a fine crenulation; pallial sinus horizontal or slightly ascending, obtusely rounded at the end.

The type of this is Linné's *V. decussata*. I am not acquainted with the reference *Cuneus reticulatus*, da Costa, quoted in Reeve's Monograph among the synonyms of this species. H. and A. Adams use the name *Cuneus* as sub-generic of *Tapes* for the present group of shells. The omission of giving the date and reference so as to be able to trace the signification in which the genus was proposed is again a great bar on this occasion. Certain it is that da Costa in his "Elements of Conchology," (1774, p. 270, pl. vi, fig. 5,) applied the name *Cuneus* to a fossil *Trigonia*, and in no way to a shell allied to the *VENERIDÆ*. Mühlfeld and others used the same in a different way, and it would probably be best not to bring it up again, for it would now only cause confusion.

4b. *Myrsus*, H. and A. Adams, 1857, ("Genera Suppl., p. 660). Shell like *Tapes*, but the surface covered with corrugated concentric striae. Type *Venus corrugata*, Deshayes.

5. *Baroda*, Stoliczka, 1870. Shell very much elongated, very inequilateral, with sub-parallel upper and lower margins, laterally compressed, pallial sinus moderate, horizontal or nearly so, obtuse at the end; hinge with three cardinal teeth in each valve, the posterior of which is very much elongated and sometimes longitudinally furrowed; the two other teeth sometimes appear as one widely bifid tooth; surface of valve smooth, only with concentric striae of growth. (Type *Venus (Tapes) fragilis*, d'Orb., from cretaceous rocks.

5a. *Icanotia*, Stoliczka, 1869. Form similar to the last, inner edge of the shell anteriorly somewhat thickened, surface covered with radiating striae and ribs, strongest on the posterior upper slope. Type *Psammobia impar*, Zittel, (vide *postea*).

Under the two above names, the second of which is probably only to be regarded as sub-generic, I unite a number of fossil, chiefly cretaceous, species which have been up to the present partially referred to *Psammobia*, partially to *Tapes*. From the former they differ widely by the character of the hinge-teeth, as I had already (p. 114) occasion to remark. They are, however, certainly closely related to the latter, but of all the numerous species of recent *TAPESINÆ* which I had examined, I never found such a difference in the length of the hinge-teeth as I have noticed above; the posterior tooth being, namely, very elongated, parallel to the ridge, or fulcrum, which supports the ligament, while the two anterior cardinal teeth, situated directly under the umbones, are small and thin: only very rarely is the most anterior or sub-lunular tooth also somewhat elongated.

Thus the known recent and fossil species of *TAPESINÆ*, (the latter only so far as their hinges have been examined) can be sub-divided into five well characterized genera and several sub-genera. The most ancient forms are those of *Baroda* and *Icanotia*, and there are even some jurassic species known as *Psammobiæ* which may belong to them. In the cretaceous beds the *Baroda* forms are most numerous, and a third type apparently identical with that classed under *Amygdala*, and characterized by radiating striæ, comes next to *Icanotia*; true *Tapes* also occur here. *Amygdala* and most of the other recent types of *TAPESINÆ* are met with in the tertiaries.*

About 85 recent species, including two or three not yet described, are known, and by far the greatest number of them are from the eastern seas. Because the determination of the fossil forms is as yet in many respects doubtful, I shall enumerate the cretaceous species referable to the sub-family subsequently in conjunction with other *VENERIDÆ*, (see further on).

b. *Sub-family*,—*VENERINÆ*.

The animals have a strong, prolonged, laterally slightly compressed foot, pointed at the end, thick at the base, but without a byssus, sometimes with a small or nearly obsolete byssal groove; the mantle has occasionally slightly crenulated margins, the outer edges being separated in their entire length; the siphons are moderately produced, united at the base, separated towards the ends, the lower or branchial siphon is usually somewhat longer and thinner than the upper, which is thicker; both have more or less fringed orifices. The shells are oval, oblong or sub-trigonal, mostly stout and robust, externally smooth or variously ornamented with concentric and radiating ribs, often covered with epidermis; the ligament is external, the muscular impressions strong, but the pallial sinus generally faint, with a small or obsolete posterior sinus. The hinge is composed of a series of strong teeth, all of which may be considered cardinal; for there seems to be a perfect parallelism between the distribution of the hinge-teeth in those forms for which the names *Venus*, *Mercenaria*, &c., have been restricted and in those which have been called *Cytherea*, (= *Meretrix*), *Circe*, &c. In both there is generally a strong lunular tooth developed in the left valve fitting into a corresponding cavity of the right one, the superior and inferior margins of which are sometimes (though not often very distinctly) elevated, thus adding two teeth to the one strictly cardinal of the right valve. In *Cytherea*, and also in the *Circe* group, we have in each valve three distinct cardinal teeth proper; one posterior elongated, directed backwards, and parallel to the ligamental ridge; two are anterior, resembling one bifid one, placed just below the beak, or very nearly so; to this comes the lunular tooth and a pit in the other valve. When we compare with this the hinge of *Venus* and its allies, it looks at the first sight very different, but apparently only because the analogy between the two seems to me to have been slightly misunderstood.

* I can only say that if *Tapes* (*Amygdala*) *decussata* from the Paris basin is really identical with the recent species, it would show a remarkable consistency in the character of *TAPESINÆ* during various times. The study of the recent forms does not, however, support this view.

In *Venus* we notice the posterior cardinal (proper) in both valves; in the left one the two anterior cardinals form one, which is always thick and often grooved or nearly bifid; in the right we find the two anterior cardinals again joined to one, often bifid, directed anteriorly and forming the postero-inferior margin of the pit; the superior margin of the latter is raised into a small compressed tooth. However, this analogy in the arrangement of the hinge-teeth is not always so well seen; in the sub-genus *Cryptogramma* the hinge-teeth are more uniform, elongated, and diverging, distinctly indicating a relation to the form of the hinge of the *TAPESINÆ*. At the same time the explanation of the hinge-teeth of *Venus* and *Cytherea*, as given above, appears to me not only to facilitate the understanding of the relation which exists between the two large generic groups of shells, but they also clearly point out the character of the sub-family and the marked difference between it and the *TAPESINÆ*.

Dr. Römer has, as already stated, published several papers on the classification and specific determination of the *VENERINÆ* in the "Malaco-zoologische Blätter" for 1866 and 1867, but as his large Monograph on this portion of "*Venus*" has not yet appeared, I shall again refer to the various generic and sub-generic groups only so far as they are important for us in a palæontological point of view, especially in connection with the study of the cretaceous fauna, for the species belonging to it have really been treated in a remarkably superficial manner.

There are among the recent forms of *VENERINÆ*, strictly speaking, only three which deserve to be separated generically, *Venus*, *Cytherea*, and *Circe*, and even the last two are, as regards the number, form, and description of the hinge-teeth, almost identical. I do not know a single instance among recent shells where it would be particularly difficult in distinguishing *Venus* from *Cytherea*, and the same may be said as regards fossils; the difficulty only rests with the preservation of the specimens. Those forms, for instance, which Hörnes (Fossil. Moll. des Tert. Beckens von Wien, vol. ii,) considers as intermediate between the two genera, and which he refers to *Venus*, properly belong to *Caryatis*, a sub-genus of *Cytherea*.

6. *Venus*, Linn., 1758. Shell oblong, posteriorly truncate, or narrowly attenuated, solid, inequilateral, the anterior side being the shorter one, hinge with three cardinal teeth in each valve, two primary and one lunular in the left, and one primary and two lunular surrounding a pit in the right valve; ligament external, long, generally in a deep groove, pallial sinus small or sometimes almost obsolete; outer surface of shell variously ribbed, lamellated, striated, or smooth. The name *Venus* has been restricted for the concentrically laminated, rather tumid species, like *V. Listeri*, Gray, and others. Several sub-genera can be distinguished, but they possess, as I shall show, no permanent characters which would entitle them to rank as genera, equivalent to those noticed among the *TAPESINÆ*, for in the present case the changes and transitions from one form into the other are really so gradual and insignificant that it is impossible to depend upon them. Reeve (Conch. Icon., vol. xiv,) has published a Monograph of the genus.

6a. *Mercenaria*, Schuhm., 1817. Shell roundly ovate, inflated, smooth, or with partially obsolete concentric striæ; hinge-teeth rather close together and

much of the form of a *Tapes*, the anteriors being large and sub-equal, as compared with other forms of *Venus*. However, in this respect, there seems to be a distinct inclination to the form of the hinge of *Venus* rather than to that of *Tapes*. *Venus mercenaria*, L., is the type of the sub-genus, and if the latter name *Mercenaria* is applied sub-generically, the species ought to be called *Venus* [*Mercenaria*] *notata*, Say, for it is certainly not desirable to have a repetition of one and the same name as genus, or sub-genus, and species.

6b. *Cryptogramma*, Mörch, 1853 (?). Shell inflated, cuneiform, posteriorly more or less narrowly produced, anteriorly shortened and thick, outer surface generally with concentric lamellæ and often also with radiating ribs, seldom prevalent over the former, which occasionally become almost obsolete in the middle; hinge with three elongated cardinal teeth in each valve, the anteriors being the smallest. The type is *V. flexuosa*, Linné; if we accept the sub-genus as possessing any value in classification, we cannot exclude from it such species as *V. pygmæa*, Lam., or *V. scabra*, Wood. H. and A. Adams state that there are only two cardinal teeth in each valve, which does not seem to me to be exactly the case. I have examined several species like *V. macrodon*, *squamosa*, *sub-nodulosa*, and others, and I always found three cardinals in both valves, very distinct in the left, but in the right one, the most anterior, usually is small, though always traceable.

6c. *Chione*, Megerle v. Mühlf., 1811 (= *Murcia*, Römer, 1857). Shell ovate or cordate, thick, concentrically lamellar or ribbed; hinge with three sub-equal, usually straight teeth in each valve; pallial sinus small, sometimes acutely triangular, or almost obsolete. The *Venus cancellata*, Linn., (Gronov.?) must be considered as the type of this sub-genus, representing the sub-ovate, strongly lamellar forms. H. and A. Adams again state that there are only two cardinal teeth in the left valve; I have examined several species, and I find the posterior tooth is here generally quite distinctly traceable and raised above the rest of the fulcrum; it is always shorter than this. The authors of the "Genera" besides distinguish four sub-genera under the names of *Circomphalus*, Klein, *Timoclæa*, Leach, *Chamelæa*, Klein, and *Marcia*, H. and A. Adams. Most of the species of the last sub-genus belong to *Hemitapes* of the *TAPESINÆ*. Römer (Mal. Bl., vol. xiv), divides the sub-genus *Chione* into four sections under distinct (generic!) names, as 1, *Omphaloclathrum*, Klein (= *Antigona*, Shuhm.) with *V. puerpera*, *reticulata*, and others, some of which appear to be typical *Venus* as restricted; 2, *Leucoma*, Römer, with *V. grata*, Say, *granulata*, Gmel., and others, which H. and A. Adams refer to *Timoclæa*; all have peculiarly granulated radiating ribs; 3, *Chamelæa*, Klein, apparently in the same sense as stated in the "Genera," with *V. gallina*, Linn., (?) &c.; 4, *Ventricola*, Römer, with *V. verrucosa*, Linn., &c.

In 1857 (Krit. Untersuchung, &c.) the same author sub-divided his *Murcia* (= *Chione*) into *Antigona*, *Chamelea*, *Leucoma*, *Anomalocardia* (= *Cryptogramma*), and *Katelsia*. The last includes among others *V. exalbida*, Chem., and *scalarina*, Lam., both somewhat of the *Pullastra* type and probably belonging to the *TAPESINÆ*.

Thus Römer's divisions are evidently not yet completed, and it is impossible to predict how the author will finally treat the subject in his large Monograph, the papers in the "Mal. Blätter" being only preliminary. Every one who looks over the numerous species which in H. and A. Adams' "Genera," for instance, have been referred to *Chione* as a genus, must admit that there is a great variety of form among them, distinctly indicating many very good sub-divisions. Römer's anomalous treatment of our nomenclature is, however, in any case quite objectionable; the introduction of distinct names for every section is not justifiable. I believe that those peculiar forms, if they are at all definable, ought to be designated as separate sub-genera of *Venus*, but we ought not to go beyond this already trinominal nomenclature.

6d. *Anaitis*, Römer, 1857, (Krit. Untersuchung, &c., Cassel, and Mal. Blätter, xii, p. 153, &c.). This ought to include the moderately tumid cordate forms with strong concentric lamellæ; the hinge is not different from that of true *Venus*, except that the anterior teeth are more elongated and more regular, as in *Chione*. Römer, in 1857, distinguished two sub-genera (?), *Clausina*, Brown, and *Chione*, Mühlf., quoting *V. thiara*, Dillw., as the type of the former and *V. plicata*, Gmel., as that of the latter; the first is stated to possess a small triangular, the latter a roundish triangular pallial sinus. In the later review of the species he does not consider the distinction of the two sub-genera (or sections) necessary.

6e. *Gomphina*, Mörch, 1855? Shell ovate, cordate, moderately inflated, smooth; hinge-teeth the same as in typical *Chione*. Römer describes four species, and considers *V. undulosa*, Lam., as the type, while H. and A. Adams quote *Venus donacina*, Chem., as the only species, and place it as a sub-genus of *Cytherea* (= *Meretrix*).

Gemma, Deshayes, (type *V. gemma*, Tott.) ought, I think, to be transferred to the *DOSINIINÆ*.

7. *Psephis*, Carp., 1865, (Proc. Acad. Nat. Sc., Phil., for 1865, p. 56). This is based upon a species described as *Chione Lordi* in Proc. Zool. Soc., London, for 1863, p. 69. There are three elongated and thin cardinal teeth in each valve; the shells are rather thin, roundish, or quadrangular, and somewhat inflated, pallial sinus small; the animals are oviparous, like *Sphærium*. In Journ. de Conch., vol. xiii, 1865, p. 135, a second species, *Ps. tellimyalis*, from California is described by the same author. The former species also occurs in young tertiary deposits of California, and Gabb adds to it *Ven. tantilla*, Gould, also living and "post-pliocene" (vide Palæont. Calif., vol. ii, p. 96). The form and general character of the type species is said to be between *Pachydesma* and *Circe*.

8. *Cytherea*, Lam., 1805,* (*Meretrix* apud H. and A. Adams and Chenu). Römer (Monog. der Moll. *Venus*, Linné, 1864, pp. 1, &c.) considers *Cytherea* as

* I adopt here the name *Cytherea*, Lam., in preference to that of *Meretrix* of the same author for reasons which are well known to every conchologist. The name has been for the last 60 years so thoroughly associated with the study of recent and fossil shells that I do not see the slightest advantage in replacing it by the older name *Meretrix*, though I could not argue with Deshayes that no one has a right to introduce a name which was given up by the author himself

a sub-genus of *Venus*, and gives its characteristic thus: "*cardo valvæ: sinistræ dentibus quatuor, quorum tribus apice convergentibus et approximatis, unico remotiuscule sub lunula; valvæ dextræ dentibus tribus divaricatis et approximatis, dente laterali (? lunulari) nullo.*" In general character the species of *Cytherea* are generally solid, smooth, or concentrically, rarely radiately, ribbed shells of an ovately cordate, or trigonal, moderately tumid form; the pallial impression is usually provided with a sinus, though sometimes very small; occasionally it is nearly entire; the cardinal teeth are often grooved or divided, but this varies greatly in the different species; the inner edge of the shell is mostly smooth. Römer distinguishes the following sub-genera or sections, which with the exception of *Meretrix* we adopt here.

8a. *Cytherea*, Lam., 1805, (*Meretrix* apud Römer). Shell triangularly cordate, generally smooth, sometimes concentrically sulcated; inner edge smooth, pallial sinus very small or sometimes nearly obsolete. Type *V. meretrix*, Linn. Römer enumerates 14 species.

8b. *Tivela*, Link., 1807, (*Trigona*, Meg. v. Mühlf., *Trigonella* and ? *Pachydesma*, Conrad). Shell triangular, with smooth surface exhibiting only striæ of growth; ligament strong; ventral margin slightly convex, internally smooth, pallial sinus moderate, but always distinct, extending horizontally and rounded at the end. Römer (loc. cit.) describes 33 species which by Reeve are mostly referred to *Cytherea*. *Cyth.* [*Tivela*] *crassatelloides*, Con., is probably the best known shell in collections.

8c. *Callista*, Poli, 1791, includes a number of cordately or triangularly ovate species, moderately compressed; smooth or concentrically sulcated; ligament slightly prominent; pallial sinus deep, sinuated and rather broad, at the end often abruptly pointed. *Cyth.* [*Callista*] *erycina*, Linn., is probably the best known form of this sub-genus. Römer describes 33 recent species.

The shell of *Cyth.* [*Call.*] *gigantea*, Chem., could probably form a special sub-genus with its allies. The form is peculiarly elongated, and so is also the posterior cardinal tooth, while the two others are small. We have a species of this type already in our cretaceous rocks.

8d. *Aphrodina*, Conrad, 1868, (Am. Journ. Conch., iv, p. 246). "Shell rounded or sub-oval, striated or sulcated*; hinge in the left valve with three diverging cardinal teeth, the anterior as thick as the middle one, or thicker, and a straight, compressed, transversally rugose lateral tooth parallel with the margin above it; pallial sinus deep, and similar to that in *Caryatis*, Römer. The type of this genus is *Meretrix Tippiana*, Conrad, of which we have one valve only which shows the hinge, and that is nearly as perfect as if the valve were a recent specimen."

who proposed it. It is, as I had already stated, to be greatly regretted that authors do not themselves retain the names which they have introduced in science, but the cases are different where an author omits a name purposely, or out of ignorance of the work of others, and where an author makes a change with the object of improving or correcting the nomenclature. Discretion in such cases is necessary. I have also previously stated my reasons for the superfluous introduction of the name *Meretrix* in a sub-generic sense. We must not introduce three names when they are not required.

* This variation in the characters evidently is in anticipation of any further species or specimens being discovered!!

The figure (Jour. Am. Acad. N. Sc., Phil., 2nd ser., iii, pl. 34, fig. 18,) of the "only" valve has actually very much the form of a *Caryatis*, and I confess myself unable to see how the shell can be generically or sub-generically separated from other fossil and recent *Caryatis*. The species is from cretaceous rocks.

8e. *Caryatis*,* Römer, 1862, (olim *Pitar*, Röm., 1857). Shell cordate or sub-trigonally ovate, usually of moderate thickness and somewhat inflated, white or yellowish brown coloured, concentrically finely striated, pallial sinus always distinct, triangular or obtuse. *Venus tumens*, Gmelin, is the type of this very well marked form of *Cytherea*; its distinction from others is of great importance in fossil conchology, for to it mostly appear to belong the oldest representants of the genus; of recent species Römer describes 60 and adds two doubtful ones; those contained in Reeve's Monograph of *Dione* sadly require a revision.

8f. *Dosiniopsis*, Conrad, 1864, (Proc. Ac. N. Sc., Phil., 1864, p. 213, and Am. Journ. of Conch., i, 1865, p. 6). Mr. Conrad (in Am. Journ. of Conch., ii, p. 100,) quotes among the typical species of this so-called generic form *Venus plana*, Sow., (= *sub-plana*, d'Orb.) from the Upper Greensand of Blackdown. To judge from this the form of the shell does not in the least differ from typical *Cytherea*, and neither does the hinge appear to differ. The species also occurs in our South Indian cretaceous deposits, and I have examined the hinge of this one as well as of authentic Blackdown specimens. The only difference I can find is, that the lunular tooth is rather elongated and almost parallel to the margin. But if we compare with this the hinge of other recent species, as, for instance, *Cyth.* [*Meretrix*] *attenuata* of Dunker, it is evident that no reason exists for a generic or even sub-generic separation. Of course, if Mr. Conrad wishes to make genera and species to suit formations, and these only, he can often detect distinctions where other people are unable to do so. Conrad considers *D. Meekii*, which is a more rounded shell, as the type species; I do not know it, but at the same time I cannot see in what to place the characters distinctive from *Cytherea*.

8g. *Dione*, Gray, 1847, (not Megerle v. Mühlfeld, as stated by Deshayes). Shell similar in form to *Callista*, moderately compressed, always concentrically densely sulcated, and with a more or less distinct ridge running from the beaks in an easy curve to the infero-posterior margin; this ridge is sometimes provided with spines; pallial sinus moderate, always distinct, usually linguiform. The type is *Cyth.* [*Dione*] *Veneris*, Arg., (= *Venus Dione*, Linné). Römer notices 13 species.

The so-called genus *Amyantis*, Con., which has been proposed for *Cyth. callosa*, Con., does certainly not deserve to bear a special name. The species only differs by having the fulcra thicker than most other species, and rugose. The general form and dentition of the hinge is extremely like *Cyth.* [*Callista*] *erycina*, (Linn.).

8h. *Lioconcha*, Mörch, 1853 (?). Shell roundish, sub-quadrangular or cordately ovate, sometimes cuneiform, more or less inflated, solid, outer surface concentrically

* In adopting this name I can only repeat what I said regarding *Cytherea*, p. 149, (footnote).

more or less coarsely striated or partially smooth, ligament thin, usually situated in a deep groove, pallial sinus only indicated by the impression being truncated or very slightly insinuated; teeth strong, except the anterior and posterior cardinals of the left valve, which are markedly thin. The two best known species are *Cyth.* [*Lioconcha*] *castrensis*, Linn., and *Cyth.* [*Lioconcha*] *arabica*, Chem.; they at the same time represent two slightly different sections; in the former the shell surface is mostly smooth, and the posterior ridge alluded to in *Dione* is here more or less distinctly indicated; in the latter the surface is concentrically ribbed or coarsely striated. Twenty-one species are described by Römer.

8i. *Circe*, Schuhm., 1817. Shell quadrangular or roundish, solid, compressed, with flattened beaks, surface concentrically ribbed, middle cardinal teeth much stronger than the others, pallial impression truncated, but not sinuated posteriorly, inner edge sometimes finely crenated; ligament situated in a deep groove. Type *V. scripta*, Linn.

8k. *Crista*, Römer, 1857. Shell cordate or transversally ovate, solid, more or less tumid, with radiating ribs or divaricated striæ; pallial sinus very small; internal margin crenated, ligament in a groove, but distinctly visible outside. There are two slightly different forms, both, no doubt, belonging to the same type. The first, represented by *V. pectinata*, Linn., and *Cyth. gibba*, Lam., has strong radiating ribs; there are, however, in young stages posteriorly some obliquely directed striæ or ribs visible, and these indicate the divaricate striation which is so well developed in the second group represented by *Cyth.* [*Crista*] *divaricata*, Chem.

The Monograph of Römer will, we may expect, contain descriptions of from 230-240 species, most of them no doubt excellently figured and described in detail. The geographical distribution of the *VENERINÆ* is a very large one, but there are some of the sub-genera which are more or less limited to certain countries, thus constituting good geographical groups. The species of *Venus* proper generally have almost the widest distribution; they are found nearly in all seas; those of *Mercenaria* are to a great extent American, those of *Cryptogramma* either American or North Australian. *Chione* are about equally divided between the American and Indian seas. Of *Cytherea* proper most of the species are Indian, and the same is the case with *Circe*, *Crista*, and *Lioconcha*; of *Callista* the largest portion of species are also Indian. *Tivela* is divided about equally between the eastern and the American seas, some few species also occurring along the coast of Africa, &c. *Dione* is almost exclusively an American form, while *Caryatis* is distributed all over the world. Speaking of older fossil forms, I principally mean to refer to those occurring in cretaceous deposits, for, as already stated, the jurassic species are as yet very little known; they only resemble *Venus*-, or *Cytherea*-forms in external shape upon which their determination solely rests. From strata lower than the jurassics we hardly know any species of *VENERINÆ*, at least none which could be with even a small amount of probability referred to the sub-family; however, the hinges of those shells are yet quite unknown.

Returning again to the cretaceous species, their determination also is to a very great extent very unsatisfactory, though we already meet here with many characteristic forms. We do not find as yet true *Venus*, but we meet with *Mercenaria*, a group less numerous in the present seas than others; some forms indicate *Chione*, but scarcely any resemble *Cryptogramma*. Species of the genus *Cytherea* are by far more numerous than those of *Venus*. We meet some, though very few, which are almost identical with recent forms of *Callista*, others very much resembling *Cytherea* proper, very few somewhat allied to *Tivela*, but most of the species appear to belong to *Caryatis*, which has a very wide geographical distribution, as already stated. All these forms are especially prominently represented in the deposits of the old continent, while in *America* we see that most of the species have been referred to the present almost exclusively American *Dione*, though, as the sub-genus has been restricted at the present, few belong to it, *Callista* and *Caryatis* besides being apparently the most common. I mention this fact merely because it is an additional proof of what I have already several times observed, that the present geographical distribution of Molluscs was to some extent indicated already during the cretaceous period. Such passing observations look very insignificant by themselves, but they are solid materials, out of which the palace for geological science must be built! As regards tertiary deposits I have little to say; the species gradually become very similar to the recent ones, and so is also their geographical distribution. *Caryatis* during the eocene epoch is still most numerous, but then it immediately passes (though scarcely in a larger number) into the present tropical fauna, for we do not find it in the miocene (of Europe and America) in any number nearly approximate to what occurs in the two last named epochs.

The classification of the recent *VENERINÆ* noted above will be a great help in obtaining an idea of the character of the cretaceous species, of which I shall give a list at the end of the general remarks on the family.

c. Sub-family,—*SUNETTINÆ*.

The animal of the single recent genus referable to this sub-family is not yet known, but I hope to be able before long to be in possession of one or two of our common Indian species. The shell is ovately elongated, moderately compressed, hinge with three or four compressed cardinal teeth and one long lunular in each valve; the posterior margin behind the beaks is peculiarly flexured, and bent inside, forming a deep cavity, sometimes with corrugated sides and containing the ligament hidden, or almost hidden; the lunula is linear; pallial sinus distinct.

The general, in many respects *Tellinoid*, character of these shells appears to make it probable that the animals will be somewhat distinct from those of the true *VENERINÆ*. Deshayes suggested, as already referred to, that *Sunetta* may belong to the *DONACIDÆ*, but the form and arrangement of the hinge-teeth is evidently that of the *VENERIDÆ*, and that author himself classes the allied *Grateloupia* in the present family. The posterior areal excavation of the *SUNETTINÆ* is very characteristic for the recent as well as for the fossil species.

Only the following three genera, *Sunetta*, *Grateloupia*, and *Cytheriopsis*, constitute as yet the sub-family; none of the genera are known from rocks older than tertiary.

9. *Sunetta*, Link., 1807. Shell elongated or roundish, sub-trigonal; hinge of the left valve with three cardinal teeth, the first perpendicular, very thin, the second obliquely directed posteriorly and thickest, the third thin and marginal; right valve with two anterior vertical cardinals and one thin sub-marginal posterior; lunular tooth very long, raised in the left valve and fitting into a corresponding groove of the right one; pallial impression moderate, rounded or sub-angular.

The surface of the valves is either smooth or concentrically sulcated, much recalling some *Cythereæ* and *Callistæ*; they are always covered with an epidermis. There are not two, but three, cardinal teeth in each valve of nearly all the known species that I have examined. The roundish forms present a passage to the *DOSINIINÆ*. *Sunetta meroë*, Linné, is the type of the genus. Reeve in his Monograph describes twelve species, all from the Indian and Australian seas; three other species have to be added, described since. Fossil species are very scarce in tertiary deposits, and seem here already to have been represented by somewhat different forms.

The only species, anything like a *Sunetta*, from cretaceous rocks are, for instance, *Lucina nasuta* and *postradiata*, Gabb, (Pal. Calif., vol. i, pl. 24, figs. 58-59), and a few others; but the hinges are as yet unknown.

10. *Grateloupia*, des Moul., 1828, (See Hörnes' Foss. Moll. von Wien, vol. ii, p. 148). Shell elongated, posterior side somewhat attenuated and narrowly rounded or sub-angular at the end, hinge with three long compressed cardinal teeth and one elongated lunular tooth in each valve; of the cardinals the posterior are more or less bifid, internal areal edges below the ligament greatly rugose and cross grooved, sometimes with an indication of a posterior lateral tooth at the end; pallial sinus deep. Only four upper tertiary species are known, *G. irregularis*, Bast., being the type of the genus.

11. *Cytheriopsis*, Conrad, 1865, (Am. Journ. Conch., i, pp. 7 and 146, and iii, p. 146). "Triangular; hinge composed of two compressed or linear teeth under the apex and two oblique anterior to them; in the left valve are four diverging teeth, the posterior one linear, and a lateral pyramidal compressed tooth anteriorly; cartilage area rugose; pallial line with a shallow rounded sinus." In spite of the differences pointed out by Mr. Conrad one cannot but entertain doubt as to the real generic distinction of the only species *Cyth. Hydana*, Con. (= *Moulinsii*, Lea), from *Grateloupia*, under which genus Lea described it, while Conrad put it under *Cytherea*. Lea's figure shows, strictly speaking, only three cardinal teeth in the left valve, and four if we count the posterior thickened areal margin as a fourth tooth, but in such a case *Grateloupia* appears to me to possess more or less distinctly also four cardinal teeth! I think a strict comparison of the two shells would be again most desirable, for the differences pointed out may exist merely in a different wording of the characters and not in reality.

d. *Sub-family*,—*DOSINIINÆ*.

The animal of *Dosinia* has prolonged united siphons, sometimes, in other genera, scarcely separated at the end, and occasionally with fringed orifices; foot large, sub-quadrangular, anteriorly slightly produced; mantle plicated at the edge; the inner lamella of the gill larger than the outer one.

Shell more or less sub-orbicular, solid, sometimes slightly elongated and inflated, of a thin structure; surface concentrically striated or laminated, pallial sinus triangular, pointed at the end, ascending.

If the animals were in all the forms now referred to this sub-family so characteristically different by their united siphons and the form of the foot as is, for instance, *D. lupina* from the animal of *Cytherea* and *Tapes*, there certainly would exist strong reason for the classification in a distinct sub-family, if not a separate family. As regards the form of the shell the group is not difficultly defined. Fossil evidence goes also to show that at least a special sub-family should be established, for numerous, some different, but, on the whole, characteristic types are already in the cretaceous period to be met with, and possibly they may also be found in lower strata; the general shape of the shell is not wanting in them, but the hinge-teeth have not yet been examined. I especially mean here to refer to the various forms of *Astarte* and *Lucina*-like shells in the Oolites.

There is also another somewhat different type of shells classed in this sub-family, one represented by the recent *Clementia*, and very likely indicated already in the cretaceous period. These shells are less distinctly orbicular, but more elongated, inflated, remarkably thin, and concentrically sulcated. I have not had as yet the opportunity of observing the animal of *Clementia*, but I greatly suspect that this is not its proper place in the system. I would be much more inclined to regard these forms as belonging to the *GLAUCONOMYIDÆ*, as already stated (p. 91). The shells are really, except in a few points of detail, as different in their whole character from those of *Dosinia* as they could be. Still as long as direct proof is not obtainable, it would be to no advantage to place them anywhere else. It is to be expected that sooner or later some thorough reform must be made in this sub-family. I have already alluded to the difficulty of classifying satisfactorily such forms as *Lucinopsis* (*Mysia* of Gray), and the same is here partially the case with *Cyclina*. The shells of both have a very great resemblance, but the animal of the former has, though short, still quite separated siphons; of the latter Gray says, "*Animal Dosiniæ simile*."

12. *Dosinia*, Scopoli, 1777. Shell orbicular, or trigonally sub-orbicular, solid, moderately convex at the sides, with pointed and slightly incurved beaks, concentrically striated or sulcated; lunula always circumscribed, often deeply excavated; sinus triangular, pointed; ligament usually in a deep groove; hinge with three cardinal compressed teeth in each valve, one anterior small lateral in the left valve fitting into a corresponding cavity of the right; this lateral tooth is sometimes nearly obsolete. Thus, as regards the dentition of the hinge, *Dosinia* may be considered intermediate between *Venus* and *Cytherea*, but distinctly inclining to the latter, especially to the sub-genus *Caryatis*, as indicated by species like *D. trigona*,

Reeve, and *D. sphaerica*, Römer. Römer in his admirable Monograph (1862-63) describes 103 recent species, (excluding several doubtful ones); they have a world-wide distribution. The genus occurs in tertiary rocks, but those of older deposits are, with few exceptions, not certain, although they appear to be represented by other similar forms, such as the two next genera.

13. *Eriphyla*, Gabb, 1864, (Pal. Calif., vol. i, p. 180). Shell sub-orbicular, moderately compressed, with pointed, approximate beaks, with a deep narrow lunula, and, on the whole, in external character much resembling *Dosinia*; muscular impressions large, but not deeply impressed, pallial sinus moderate, roundish, slightly ascending; hinge strong, in the right valve with two cardinal teeth, the central one strong and thick, often grooved, the anterior thinner and marginal; in left valve also with two cardinal teeth, the sub-anterior thick, the posterior thinner; one small anterior lateral (lunular) tooth of the left valve fits into a corresponding pit of the right, and another small longish posterior and remote one of this valve into a corresponding cavity of the left valve. The best known species is *Lucina lenticularis*, Goldf., from the cretaceous beds near Aachen.

This is a very different shell from *Dosinia* as regards hinge-teeth as well as the form of the pallial sinus. It appears very probable that some of the jurassic *Astarte* (*A. excavata* and others) belong to this genus, but a very careful examination of the hinge and of the pallial line, which is broad, though very faint, and also of its sinus, will be necessary. The hinge-teeth of *Eriphyla* closely approach those of *Astarte*, but these have no distinct lateral teeth, nor a deep lunula or a sinus.

The genus was first proposed by my friend Gabb for a Californian cretaceous species, *E. umbonata*. His figure of the hinge of the two valves and the statement of the presence of a deep lunula leaves no doubt that we have a shell of the *DOSINIINÆ* before us, and not a species of the *ASTARTIDÆ* to which the shell in question was referred by Gabb, though there can be no doubt that on account of the great similarity of both, one may easily be mistaken for the other.

In the cretaceous rocks there are likely a great many species to be found belonging to the present genus. I will point this out subsequently, particularly when enumerating the species described under the generic name *Astarte*. The type species, with two others also, occurs in our South Indian cretaceous deposits.

14. *Gemma*, Deshayes, 1853. Shell small, roundish, smooth, pallial line with a deep almost perpendicular sinus; hinge of right valve with two primary teeth, of the left with three, the middle one of which is by far the thickest. The type of this genus is *Venus gemma*, Totten; it seems, as already stated, very undesirable that a repetition of the generic and specific name should occur; the present species could be called *Gemma Totteniana* in the absence of any other synonyms. *Venus cerina* and *globulus* in Reeve's Monograph of *Venus* are externally closely allied to *Gemma*, though the latter may rather be a *Dosinia*. In Annals of the Lyc. of N. York for 1862 Prime describes a *Venus (Gemma) Manhattenensis* (p. 482). The form of the shell and its close relation to the fossil *Cyprimeria* appear to me fully to bear out the present classification.

15. *Cyprimeria*, Conrad, 1864, (Proc. Ac. Nat. Sc., Phil., 1864, p. 212). Shell sub-orbicular, of moderate thickness, with the valves more or less compressed, concentrically striated, rarely with radiating striæ; pallial sinus small and obtuse, or distinctly angular and deep; hinge in the right valve with two diverging pairs of thin laminar cardinal teeth, each pair originating from one point, and thus preserving the character of a single bifid tooth, left valve with three cardinal teeth, the first and second are slightly diverging, and both strongly compressed, the anterior being the thinner one, the posterior tooth is parallel to and separated only by a shallow groove from the very thick fulcrum; lunula not much or not at all impressed, but beaks pointed and approximated. None of the species that I have examined possessed a regularly margined lunula. There is on the dental area of the hinge a distinct impression below the lunula of both valves, and if observed in one only, it may give rise to a supposition that this pit corresponds to a tooth in the other valve, but that is certainly not the case in any of the species of which I have been able to examine both valves; and judging from analogy, it is not likely to be the case in others which are believed to possess it. And should it really be the case in any of them, those species must be referred to *Dosinia* proper, as the type of the present genus is considered to be *Cyprimeria excavata*, Morton.

This is a very well marked type of cretaceous shells, belonging to the *DOSINIINÆ*, as shown by the general character and especially the dentition of the hinge, and not to the *TELLINIDÆ*,* in which family it is classed by Conrad. The genus is equally well separated from *Gemma*, and appears as yet to have been found in cretaceous deposits only. I shall enumerate further on the cretaceous species which have been described under different genera, as partially pointed out by Conrad (Am. Journ. Conch., ii, p. 102). Many of the fossil *Lucinæ* and *Astarte* may prove to be *Cyprimeriæ*. The genus also occurs in the eocene of Sind and other parts of India.

16. *Cyclina*, Deshayes, 1849, (vide Deshayes in his list of Conchifera in the British Museum, 1853, p. 29). Shell sub-orbicular, thin, concentrically or radiately striated, hinge with three cardinal, diverging teeth in each valve, the most anterior of the right valve sometimes obsolete or nearly so; pallial sinus triangular, generally ascending. Type, *Venus Chinensis*, Chemn. Deshayes (loc. cit.) describes twelve recent species, all of which do not, however, appear to belong to this genus. Some are identical with known forms, but a few others have been described since.

The thin structure and dentition readily distinguish this genus from *Dosinia*, or any of the other genera mentioned. The genus is known to occur in tertiary, but as yet not from older deposits, for Zittel's *Cyclina primæva* is a *Cyprimeria*.

17. *Clementia*, Gray, 1840.† Shell elongately ovate, tumid, very thin, covered with epidermis, pallial and muscular impressions faint, pallial sinus narrow,

* Some species particularly have a remarkably great external resemblance to *Arcopagia*, having also been described as such by d'Orbigny.

† Vide Malacoz. Blätter, vol. xvi, p. 190.

ascending, nearly pointed at the end, resembling that of *Gemma*; hinge with three teeth in each valve, very thin and laminar, the two anterior in the right and the two posterior in the left closely approximate, the former almost perpendicular, the latter very oblique, they appear almost as one entirely divided tooth; besides that there is a single perpendicular anterior cardinal tooth in the left and an oblique posterior, sometimes very slightly bifid, tooth in the right valve; the ligament is sub-external, in a deep groove, and rather strong externally. Type *C. papyracea*, Gray. I have already stated that doubts can be entertained as to the proper classification of this genus in this place, but the animal is said to resemble *Dosinia*. The shells, with the exception of the angular pallial sinus, have scarcely anything in common with each other.

H. and A. Adams quote six species from the Philippines and from Australia; one is said to occur at Ceylon. I do not know the habitat of these. I obtained two apparently new species near Calcutta in brackish water, but have not as yet been successful in observing the animal. Both the shells are typical *Clementiæ*, very thin: one greatly recalls *Tanysiphon* or *Glaucomya*, both of which are also brackish, and have an animal like *Anatina*; the other species is more inflated and also occurs near Púrí in a salt water lake (Chilka) and in the Irawadi Delta; possibly it is the species noted from Ceylon. As previously observed, I think it more probable that the genus will be better classed in the family *GLAUCONOMYIDÆ* than in the *VENERIDÆ*; but unless the animals be re-examined, it will be impossible to come to any definite conclusion on this point.

18. *Thetironia*, Stol., 1870, (*Thetis*, Sow., 1826, Min. Conch., vi., p. 19, non *Thetys* = *Thetis*, Cuv., 1808). Shell roundly oval, tumid, very thin, somewhat inequilateral, beaks incurved and rather close to each other; hinge apparently with one median larger and two smaller cardinal teeth, pallial line acutely angular and very deep, reaching almost to the beaks. Type *Th. minor*, Sow.

I have not seen a single specimen belonging to this genus with the shell preserved, but it seems to have been very thin, and there can be little doubt that all the external characters indicate a close approach to the recent *Clementia*. The hinge-teeth are only known from impressions, and even these have not as yet been observed in a perfect state. The principal characteristic of the genus lies in the remarkably deep, posteriorly, narrowly, and angularly bent pallial impression. The species of *Thetironia* are as yet only known from cretaceous deposits.

In looking over the various forms which have been referred to the *DOSINIINÆ*, we observed that there were scarcely any species known from palæozoic beds; in the lower mesozoic deposits shells of *Dosinia* – form occur, but they have not as yet been sufficiently discriminated from *Lucina*. In the jurassics we have also only a few doubtful *Dosiniæ*, but several species of *Eriphyla*; in the cretaceous *Cyprimeria* and *Thetironia*, and very likely also *Dosinia* are added. *Gemma* and *Cyclina* are as yet doubtful, but they certainly occur in the lower tertiaries, and from the miocene time *Dosinia* greatly prevails over all the other genera. There are about 130 recent

species belonging to this sub-family known; somewhat or scarcely half the number of species is known from tertiary deposits, about one-third from the cretaceous, and about one-fourth, or perhaps less, from the jurassics, (unless the species of *Eriphyla* turn out to be particularly numerous).

LIST OF CRETACEOUS SPECIES OF *VENERIDÆ*.

In enumerating the cretaceous species belonging to the present family, I shall first note those mentioned by Pictet and Campiche, who refer them summarily to the single genus *Venus*, which the authors adopt in Linné's sense, (Paléont. Suisse, 4^{me} ser., 3^{me} part., p. 186, 1865). It is surprising to meet with such a treatment of this interesting group of shells in the hands of a celebrated Palæontologist like Pictet, who considers *Tapes*, *Cytherea*, and *Dosinia* as in some respects inferior sub-divisions of *Venus*. Surely the hinge-teeth of a good many cretaceous species have been examined, and it seems to me a very wrong principle to ignore those,—even were they only few,—because we do not know the hinges of all the species. Under such circumstances fossil conchology would never have a chance of becoming more than a helpless instrument in the hands of those who wish to make use of it in the identification of strata. No doubt, if this object were only attained, it would possess its great value. However, I fear that even those casts upon which Pictet and Campiche, and many others,* base their species, and of which they say that they are merely intended for assisting in the study of the relations of different beds in which they occur, are of very little use to the geologist. It is extremely difficult to identify strata by such casts, which no field geologist will deny; and if specimens are found with the shells preserved, a determination of the species becomes extremely difficult, for the shells of the *VENERIDÆ* often possess near the margins and especially at the beaks such thickness that it is impossible to make more than a very generally correct conclusion from the form of the one as to that of the other.

These introductions of very imperfect fossil species are also objectionable for another reason, because they often involve unnecessary changes in specific names, as has, for instance, been largely done by d'Orbigny. Many of the original specific names have to be again restored as soon as a correct generic determination of the shells has been obtained.

The list of the cretaceous species which I give here must be considered for the present only as a very poor attempt at a revision of the numerous cretaceous forms, but much may be done by those who have a large stock of materials accessible, for since the publication of the first descriptions of many of the fossils better specimens have no doubt been obtained. I was myself fortunate enough to see several during my visit to Europe in 1867. I need only remark that the observation of an anterior impression of a tooth in front of the beaks does not in all cases warrant the conclusion that the shell was one of the *Cytherea* group, because I have already explained that in *Venus* as well as *Cytherea* the lunular teeth are analogous, and the difference lies in a modification of the true cardinals; this to some extent also applies to the *TAPESINÆ*.

1.—*Venus sub-Brongniartiana*, d'Orb., (*Brongniartiana*, Leym.,) agrees in general character partially with *Tapes*, partially with *Callista*, or it may even be an elongated *Cyprimeria*. Schafhäutl (Süd. Bayerns Leth. Geog., 1863, p. 170, pl. xliii, fig. 2,) refers to this a species which is similar in form, but decidedly much thicker; the figured specimen is a cast and the pallial line is shown entire; it is likely quite a different shell from the above.

2.—*V. Ricordeana*, d'Orb., has the form of a compressed *Cytherea*.

3.—*V. Matronensis*, d'Orb., may be a *Tapes*.

4-5.—*V. Robinaldina* and *Cornueliana* of d'Orb. recall some forms of *Callista*.

* The so-called species of shells described by Coquand in his work on Constantine, and also in the Monograph of the Étage Aptien of Spain, as likewise those in Lorient's work on the fossils of the Monte Salève, are formed with but little regard to the generic characters, and are to a great extent useless.

6.—*V. Thurmanni*, Lor., equally so.

7-9.—*V. helvetica*, P. and C., *V. obesa*, d'Orb., and *V. Escheri*, Lor., are probably *Caryates*, though the second, as figured by d'Orbigny apparently with the shell, also greatly recalls a *Hemitapes*. Eichwald (Leth. Ross., livr. xi, 1867, p. 711, pl. xxvi, fig. 8,) describes as *V. obesa* a species which is much less inflated and has the anterior end much longer than the specimen figured by d'Orbigny.

10-11.—*V. Galdrina*, d'Orb., and *V. Varapensis*, Lor., are probably *Cythereæ*.

12.—*V. Cottaldina*, d'Orb., recalls some of the smoother forms of *Chione*.

13.—*V. sanctæ-crucis*, P. and C., has somewhat the form of a *Pullastra*.

14.—*V. Dupiniana*, d'Orb., likewise so.

15-16.—*V. Vendoperana*, (Leym.) = *neocomiensis*, d'Orb., and *V. Icauensis*, d'Orb., both are probably *Cyprimeriæ*, having a *Dosinia*-like form without an excavated lunula, resembling in this respect *Circe*, to which some other cretaceous species of *Cyprimeria* have been referred. Eichwald (Leth. Ross., xi, 1867, pp. 713 and 716,) quotes both the species from the neocomien of Russia. But as that author's interpretation of neocomien rocks is in some instances doubtful, his identifications (without exact figures) must be accepted with hesitation. He also quotes several other species, as *V. parallela*, Münster, *Robinaldina*, d'Orb., *faba*, Sow., *Dupiniana*, d'Orb., and *immersa*, Sow., upon which it would be equally difficult to pronounce an opinion.

17.—*Artemis cordata* may be an *Eriphyla*, because it has the lunula excavated, but it could also be a *Dosinia*.

18.—*Art. inelegans*, Sharpe, is most likely a *Cyprimeria*.

19-20.—*Ven. Vassiacensis*, d'Orb., and *V. Roisii*, d'Orb., are perhaps *Caryates*.

21.—*V. Vectensis*, Forb., is very much like, and may be identical with, *Eriphyla lenticularis*, Goldf., sp.

22.—*V. parva*, Sow., (Min. Conch., pl. 518, figs. 4-6, not figs. 1-3,) is evidently a small *Caryatis*.

23.—*V. Orbignyana*, Forb., is similar to the last.

24-26.—*V. Vibrayeana*, d'Orb., *V. Rouliniana*, Cott., and *tenera*, Sow., are probably also *Caryates*.

Pictet and Campiche here indicate from the "Gault inferieur" of Cosne several as yet undescribed species, most of which appear to belong to *Cytherea*; judging from the references made to allied forms, some few may belong to *Cyprimeria*.

27.—*V. caperata*, Sow., (Min. Conch., pl. 518, figs. 1-3,) is a typical species belonging to the sub-genus *Caryatis*.

28-29.—*V. ovalis* and *faba*, Sow., are probably identical; they very much resemble somewhat oval forms of *Cyprimeriæ*, and the former especially is extremely like our South Indian *Cyp. Arcotensis*.

30-31.—*V. lineolata* and *plana*, Sow., are also most probably identical. I have seen various specimens from the original locality at Blackdown, but the anterior side varies, being slightly longer or shorter, and so also does the greater or lesser convexity of the shell. The same species also occurs in South India, and here I observe similar variation. To prevent mistakes with the recent *Cytherea* [*Caryatis*] *lineolata*, Sow., the second, to palæontologists better known name, *plana* ought to be retained. Judging from these variations I am in doubt whether the form originally described in the Pal. française by d'Orbigny under Sowerby's name *plana* and afterwards called *sub-plana* is a different species. The hinge is certainly in both the same. Conrad quotes the species *plana*, Sow., among his typical *Dosiniopsis*, but I have already stated that the difference in the lunular tooth does not seem to me to be a sufficient character for a generic or even sub-generic distinction from *Cytherea* proper,—(for further particulars see p. 169).

- 32.—*V. sub-rotunda*, d'Orb., (*rotundata*, Sow.) is a *Caryatis*.
- 33-34.—*V. immersa* and *sublævis* of Sowerby both are probably *Cytherea*; the former could also be an oval *Cyprimeria*.
- 35-36.—*V. sub-truncata*, d'Orb., (*truncata*, Sow.), and *V. submersa*, Sow., belong to *Caryatis*.
- 37.—*V. ...* = *Venus faba*, Sow., apud d'Orb. This may be identical with our Indian *Cytherea* [*Callista*] *fabulina* (see p. 174).
- 38.—*V. Cenomanensis*, d'Orb., is *Baroda fragilis*, (d'Orb.), belonging to the sub-family *TAPESINÆ*, and described by Zittel as *Tapes fragilis*, d'Orb., sp., from the Gosau (vide Denksch. Akad., Wien, 1865, vol. xxiv, pt. ii, p. 122, pl. iii, fig. 3).
- 39.—*V. Rotomagensis*, d'Orb., apparently a *Caryatis*.
- 40.—*V. Astieriana*, Math., most likely a true *Cytherea*.
- 41.—*V. Labadyei*, d'Arch., a ? *Caryatis*, or *Cyprimeria*.
- 42.—*V. Renauxiana*, d'Orb., was proposed for the form referred in the Pal. franç. to *V. plana*, Sow., and is said to differ in being much more compressed than this. No reference is made to the figures, or any special description, and no opinion can, therefore, be pronounced without the originals.
- 43.—*V. Noueliana*, d'Orb., is said to be allied, but more tumid than *Cyth. plana*.
- 44.—*V. Martiniana*, Math., is a *Paratapes* of the *TAPESINÆ*, and ought to stand as *Paratapes lævigata*, Sedg. and Murch. (see Zittel in Denksch. Akad., Wien, xxiv, pt. ii, p. 123).
- 45.—*V. sub-lenticularis*, Haime, is evidently a *Cyprimeria*, in which the middle tooth of the right valve is bifid, unless it is a slight deficiency of the drawing.
- 46.—*V. cuneiformis*, Duj. The impressions on the cast, as seen in the figure 5a, appear to be those of a *Cyprimeria*; it is a somewhat oval form.
- 47.—*V. jucunda*, Duj. This is one of the very few cretaceous forms I know, the ornamentation and solid shell of which closely resemble *Venus* proper, but the specimen is so imperfect as not to allow of a correct determination of the genus; it could with almost equal probability belong to *Linearia* of the *TELLINIDÆ*.
- 48.—*V. sub-plana*, d'Orb., is said to be again different from the *V. plana* in the Pal. franç., vol. iii, pl. 386, figs. 1-3 (vide p. 160 and p. 169).
- 49.—*V. Royana*, d'Orb., probably a *Baroda*, or another genus of the *TAPESINÆ*. Schafhäutl (Süd-Bayerns Leth. Geog., 1863, p. 171, pl. xxxviii, fig. 3,) figures under this name a shell which I hardly believe could belong to this species, but much more probably to the *MYIDÆ*. The ideas indicated of the conchological value of a species are quite as singular as those of geological formations!
- 50.—*V. Archiaciana*, d'Orb., is most likely an elongated *Cyprimeria*.
- 51.—*V. Lamarcki*, Math., may either be an *Eriphyla* or an *Astarte*.
- 52.—*V. late-sulcata*, Math., ? a *Callista*.
- 53.—*V. ovum*, Math., mostly resembles such recent forms as *Tapes meroeformis*, Sow., which belongs to a special section of *Pullastra*.
- 54.—*V. turgida*, Math., (*subturgida* or *pseudoturgida*, d'Orb.) is most likely a *Caryatis*.
- 55.—*V. Lapeyrousana*, Leym.
- 56.—*Artemis elegantula*, Sharpe, is most probably a *Cyprimeria*.
- Pictet and Campiche have, I believe, very good reason to hesitate in giving a list of the German and Bohæmian and other cretaceous species, on the ground that the identification of these with foreign species may not be correct. I have myself seen a good many of them; but unless one undertakes the difficult task of searching after the originals and is successful in this, nothing positive can be said regarding the correctness of these determinations, or otherwise.
- 57.—*V. sub-ovalis*, d'Orb., (*V. ovalis*, Goldf., *Nucula concentrica*, Gein.) must stand as *Cytherea* [*Caryatis*] *ovalis*, Goldf., sp. I have examined very good specimens of both valves received

through the kindness of Dr. Bosquet. The lunular tooth in the right and the corresponding pit in the left valve are very distinct. In the latter the two anterior cardinals are very close together, as in *Cyprimeria*; the posterior is also deeply grooved; in the right the middle cardinal is by far the thickest; the two others thin, and especially so the posterior; the pallial sinus is deep, somewhat ascending and sharply angular at the end; the convexity of the shell is slightly greater than could be supposed from Goldfuss' figure.

58.—*V. sub-faba*, d'Orb. (*V. faba*, Goldf.). Goldfuss' figure represents a shell slightly more attenuated posteriorly than that figured by Sowerby, but I do not know whether there is sufficient reason for a specific distinction. Sowerby's *faba*, I suspect, is a *Cyprimeria*. *V. fabacea* of Römer which Müller identifies with it is, however, evidently quite a different shell.

59.—*V. elliptica*, Römer. If it be the same as, or allied to, *V. fragilis*, d'Orb., it belongs to the new genus *Baroda*.

60.—*V. Goldfussi*, Gein., (*V. parva*, Goldf. = *V. sub-parva*, d'Orb.). Goldfuss' figure resembles a cast of Müller's *V. tumida*, which is a small *Caryatis*, but Geinitz' representations and descriptions (Char. p. 76, pl. xx, figs. 6-7,) would rather indicate an *Eriphyla* with an excavated lunula.

61-63.—*V. bavarica*, *parallela*, and *gibbosa* of Münster are all doubtful; the first could belong to *Eriphyla* and the third to *Cytherea*. Schafhäutl, (Süd-Bayerns Leth. Geog., 1863, p. 170, pl. xliii, fig. 7,) calls a cast specimen *V. gibbosa*, Münt.; it certainly very little agrees with the original figure in Goldfuss' "Petræf. Germaniæ," and may be a different shell altogether.

64.—*V. sub-decussata*, Römer. Judging from external appearance only, no reasonable objection could be raised as to this species belonging to the sub-genus *Amygdala* of *Tapes*, but *Nucula* when devoid of the upper layer of the shell often show similar radiating ribbings or striæ.

65.—*V. concentrica*, Röm., (*V. sub-concentrica*, d'Orb.); this could be a *Cyprimeria*.

66.—*V. lata*, Röm., most likely a *Cytherea*, or perhaps belonging to the sub-genus *Mercenaria*.

67.—*V. fabacea*, Röm. Müller, as already stated, and apparently also Bosquet, unite this with d'Orbigny's *V. sub-faba* (*faba*, Goldf.).

68.—*V. laminosa*, Rss., (*sub-laminosa*, d'Orb.,) appears to be an *Eriphyla*, if it be not a *Lucina*.

69.—*V. (Cytherea) elongata*, Rss., (*sub-elongata*, d'Orb.,) has, if not by accidental pressure, a peculiar form which greatly recalls some recent species of *Tapes*.

70.—*V. tumida*, Müll. The right valve of which I have examined the hinge shows that the species is most probably a *Cyprimeria*. There are two widely diverging bifid teeth pretty distinctly visible. The shell is generally more uniformly convex than shown in Müller's figures.

71.—*Venus? exuta*, Nillson, (Petrif. Suecana, &c., 1827, p. 17, pl. iii, fig. 16). I do not know a single species of *VENERIDÆ* with which this shell could be compared. It is oblong, inequilateral, with pointed beaks, with a few concentric striæ and numerous fine radiating ribs on the posterior side. It could be a species of *Psammocola*, or *Psammobella*, or perhaps a *Linearia* of the *TELLINIDÆ*, but I do not know any others, unless the shell is referable to *Anatina* or *Thracia*. Nillson apparently makes it the type of his *Venulithes*, under which name he means to include the cretaceous representants of Linné's *Venus*.

72.—*V. Matheroni*, Zitt., is a species of *Cytherea*, belonging to the section which Conrad called *Dosiniopsis* (see p. 151).

73-74.—*Cytherea Hörnesi* and *polymorpha*, Zittel, belong to the sub-genus *Caryatis*.

75-76.—*Venus primæva*, (*Cyclina id.*, Zittel), and *V. cretacea* (*Dosinia id.* Zittel), belong to *Cyprimeria*.

77.—*V. eximia*, (*Tapes id.*, Zittel,) is a typical species of the new genus *Baroda*.

78.—*V. Rochebruni* (*Tapes id.*, Zittel), I would rather suspect to be a small *Callista* than a member of the *TAPESINÆ*.

79.—*Donacilla compressa*, d'Orb., (Pal. franç., iii, pl. 376, figs. 3-4), belongs apparently to *Baroda* of the *TAPESINÆ*.

80.—*Psammobia impar*, Zittel, (Denksch. Akad., Wien, xxiv, pt. ii, p. 120,) is a species of the sub-genus *Icanotia*, and the species may provisionally stand as *Baroda* [*Icanotia*] *impar*, Zittel, sp., for it is not very improbable that Matheron's *Solen elegans* is also an *Icanotia*, though quite distinct as species.

81.—*Psammobia discrepans*, Duj., (Mem. Soc. Géol., France, ii, p. 223, pl. ii, fig. 2). The figure of the fragmentary shell leaves one in doubt whether the species may not be one of the *PSAMMOBIINÆ*, but that of the cast is more indicative of a species of *Icanotia*. If d'Orbigny's figure (Pal. franç., iii, pl. 381, figs. 3-5,) is correct, there can be little doubt about this.

82.—*Solen inflexus*, Duj., (ib. p. 202, pl. ii, fig. 4,) is also more likely a *Baroda* than anything else. In such cases as this, where imperfect casts are considered to be sufficiently characteristic of a species, there is, however, a great difficulty to distinguish between the *TAPESINÆ* and some *PHARELLINÆ* of the *SOLENIIDÆ*.

83.—*Capsa Arnaudi*, H. Coq., (Bull. Soc. Géol., France, vol. xvi, p. 1000). The description indicates a species of *Icanotia*.

84-85.—*Psamm. Suessi*, Zitt., (Denksch. Akad., Wien, xxiv, pt. ii, p. 121, &c.), and *Tellina Venei*, d'Arch. (Bull. Soc. Géol., France, 2nd ser., vol. xi, pl. ii, figs. 1-2,) are typical species of *Baroda*.

86.—*Circe discus*, Math., sp. (Zittel in Denksch. Akad., Wien, xxiv, pt. ii, p. 128, pl. iii, fig. 7), is a *Cyprimeria*. Pictet and Campiche (Pal. Suisse, 3^{me} ser., 3^{me} pt., p. 197,) discuss the question as to the discrepancy in the existing accounts of this species at length, and very properly. There can be little doubt that the species described and figured by Matheron (Cat., p. 144, pl. 13, fig. 12,) is the true *discus* of Zittel, for he compared the Gosau specimens with one sent to him by Matheron himself. I have myself exposed the pallial line on three of the Gosau specimens, and I can testify to the correctness of Zittel's drawing (in fig. 7e). I would not call the pallial impression an entire one; it is distinctly insinuated, though the sinus is very shallow and rounded, at least as far as the impressions on the casts go; we do not find it sometimes stronger in species of *Cytherea* or *Venus*. Variations of that kind, as I had already often mentioned, are by no means rare. It is more likely that d'Orbigny was mistaken in his figure (4, pl. 379), for in any of the species of *Cyprimeria* that I have seen, I have not observed such a broadly rounded sinus; still there is no reason that the form could not occur, and if this shape of the sinus be confirmed, the form must be considered to be a different species under d'Orbigny's name *Cyp. numismalis*.

87.—*Arcopagia Cenomaniensis*, d'Orb., (Prod., ii, p. 158,) said to be allied to *Arc. (Cyprimeria) discus* of the same author.

88-89.—*Arcopagia rotundata*, d'Orb., (Pal. franç., pl. 379, figs. 6-7,) and *Circe concentrica*, Zittel, (loc. cit., p. 130, pl. 4, fig. 1,) are *Cyprimeriæ*.

90.*—*Circe dubiosa*, Zittel, (ibid. fig. 2). I think Zittel is correct in referring this species to the same genus as the last named species. I succeeded in breaking up a specimen partially devoid of shell. The left valve distinctly shows two thin diverging teeth under the umbo and a third posterior long one, being very thin; in the right valve I can also notice two diverging teeth, but they are not very distinct; there are no other teeth under the lunula, so the species is not a *Circe*. It, on the whole, somewhat resembles *Venus nuciformis*, Müll., and is, therefore, still more likely a *Mercenaria*. The beaks are incurved, but the edges of the lunula are, as in *Cyprimeriæ*, straight, not excavated.

* I shall continue the numbers, though they must not as yet be accepted as indicating so many distinct species.

91-92.—*Astarte Koninckii* and *cyprinoides*, d'Arch., (Mem. Soc. Géol., France, 2nd ser., ii, pl. xiv, figs. 4-5). The former is certainly an *Eriphyla*, and may be identical with the type *Eriph. lenticularis*, (Goldf.); the latter has also the hinge of the left valve similar to that of *Eriphyla*, but it is not sufficiently distinct, and the shell has the lunula not excavated; it may, therefore, more likely be a *Cyprimeria*.

93.—*Venus nuciformis*, Müll., (Suppl. zur Monog. Petr. Aach. Kreidef., 1859, p. 13, pl. 7, fig. 14). This is a rounded, small, and rather globose, but apparently a typical species of *Mercenaria*. Müller's representation of the hinge-teeth of the right valve hardly gives a good idea of what they really are. This valve has three teeth; the posterior is thick, strongly elevated, provided with a shallow groove; of the two anterior the first is thin, and at the base attached to the lunular margin; the posterior or middle is thick, less oblique, and perfectly separated from the former. Were these two anterior teeth uniformly built the species should be considered a *Cyprimeria*, but that is not the case. The left valve has as usually three sub-equal diverging teeth, the anterior forming at its base with the middle tooth an internal angle of about 75 degrees. The fulcrum are in both valves strong and distinctly separated from the teeth, which is also not usually the case in the left valves of *Cyprimeria*.

94.—*Venus ? porrecta*, Müll., (ibid. p. 14, pl. 8, fig. 2,) a rather oblique, ovoid, sub-compressed form; may be a *Cyprimeria*, but nothing is as yet known of the hinge.

95.—*Venus Cleophe*, Coquand, (Monog. de l'étage Aptien, de l'Espagne, 1865, p. 103,) is probably a *Caryatis*.

96.—*V. Rouvillei*, Coq., (ibid. p. 104), most likely an oval *Cyprimeria*.

97.—*V. Costei*, Coq., (ibid. p. 105) ? a *Caryatis*.

98.—*V. sylvatica*, Coq., (ibid.) greatly resembles *Hemitapes*, and also some *Cythereæ*.

99.—*Tapes parallela*, Coq., (ibid. p. 106,) may be *Tapes*, but more likely a *Baroda* on account of the smooth shell-surface.

100.—*Dosinia Argine*, Coq., (ibid. p. 107,) may be *Eriphyla*, or a *Dosinia*, if the lunula be excavated; it is merely said to be "*courte, cordiforme*" and with "*bord palléal arrondi*;" this seems rather to indicate the former genus.

101.—*Dosinia Euterpe*, Coq., (ibid.); the cast gives no indication of what the shell may really be.

102-103.—*Circe conspicua* and *lunata*, Coq., (ibid. pp. 108-109). In external form these two correspond most with *Cyprimeria*.

Several of the other species described by Coquand under *Cyprina* and *Astarte* may belong to the present family, but the author does not in even a single instance indicate the form of the hinge and its impression on the casts, &c.

104.—*Capsa Cenomaniensis*, Guéranger, (Album Paléont. de la Sarthe, 1867, pl. xv, fig. 8,) is an *Icanotia*, which is a sub-genus of *Baroda* (*TAPESINÆ*). Although there is already a species, *Baroda Cenomanensis*, d'Orb., (vide No. 38), Guéranger's name may stand, because the sub-genus is different, and if further good materials are collected, it may prove to be generically distinct from *Baroda*.

105.—*Capsa Colonæ*, Guér., (ibid. fig. 10,) is slightly more elongated than the last, but otherwise not very distinct. A strict comparison is difficult, because the former shell has evidently suffered by pressure and is not quite perfect. I hardly think that both are specifically distinct.

106.—*Astarte circularis*, Guér., (ibid. fig. 12,) could much more probably be a *Cyprimeria* or one of the closely allied genera, than an *Astarte*.

107.—*Capsa concentrica*, Guér., (ibid. fig. 14,) very much recalls *Baroda* [*Icanotia*] *discrepans*, Duj., (vide No. 79), and may not be specifically distinct from it.

108.—*Lucina Nereis*, d'Orb., Guér., (ibid. fig. 15). The hinge of the right valve which Guéranger figures indicates a *Cyprimeria*, for it does not show any lateral teeth; the bi-division of the posterior cardinal is also not distinct.

109.—*Venus glabra*, Schafhäutl (Süd-Bayerns Leth. Geog., 1863, p. 171, pl. 43, fig. 4), has the general form of a small *Cytherea* or *Mercenaria*, but I am afraid further identification is hopeless.

From Africa the following species have been recorded, mostly based upon insufficient casts.

110-120.—*Venus Dutruei*, *Cleopatra*, *Mousæ*, *Reynesi*, *Mauritanica*, *Desvauxi*, *Delettrei*, *Nail*, *Forgemolli*, *Didonis*, *Fatima*, *Cherbonneau*, and *Saportæ* of H. Coquand (Constant, pp. 193-195), nearly all from the "étage Rotomagien." It would be a vain task to speculate upon the correct generic determination of such worthless materials. Most of them may be *Cythereæ* and *Caryates*, some like *V. Delettrei* and *Forgemolli* belong to *Cyprimeria* or perhaps to *Eriphyla*.

The following are from America.

121-143.—*Cyclina*? *circularis*, M. and H.; (*Dosinia*) *Cyprimeria densata*, Con.; *Dos. depressa*, Con.; (*Dos.*) *Cyprimeria excavata*, Morton; *Dos. Haddonfieldensis*, Lea = *Cyprimeria cretacea*, Con., (Am. Journ. Conch., iii, p. 9); *Dos. obliquata*, Con.; *Dos?* *tenuis*, Meek; *Dione Delawarensis*, Gabb; *D. Eufalensis*, Con.; *D. Lamarensis*, Shum.; *D. Deweyi*, M. and H.; *D. leonensis*, Con.; *D. Missouriana*, Mort.; *D. Nebrascensis*, M. and H.; *D. orbiculata*, H. and M.; *D. Owenana*, M. and H.; *D.?* *pellucida*, M. and H.; (*D.*) *Texana*, Con. (= ? *Cyprim. Texana*, Röm.); *D. tippiana*, Con.; *D.?* *Meekana*, Gabb.; *D.?* *Ripleyana*, Gabb.; *D.?* *tenuis*, Hall and M.; *Venus?* *sub-lamellosa*, Shum. (Vide Meek's Check-list of Inv. N. Am. fossils, Smith. Misc. Coll., No. 177, 1864, p. 13).

144-159.—From Conrad's "Check-list", &c., (Smith. Misc. Coll., No. 200, 1866, pp. 6, &c.), that author's older eocene species probably have to be added—*Dosiniopsis alta*, Con.; *D. Meekii*, Con.; *D. lenticularis*, Rogers, *Venus?* *lamellifera*, Con.; *V. securis*, Shum.; *Dione brevilineata*, Con.; *D. Conradiana*, Gabb; *D. Californiana*, *D. eversa*, *lenis*, *licata*, *Oregonensis* of Conrad, *D. ovata*, (Rogers); *D. perbrevis* and *Uvasana*, Con., and *D. varians*, Gabb.

160-181.—In the 2nd vol. of the Palæont. of California, pp. 209, &c., Gabb gives a list of all Californian cretaceous fossils. In this list, besides those given already, some of the species having been previously described by the same author in vol. i of the same publication, occur—*V. Veatchii*, G.; *V. lenticularis*, G.; *V. tetrahedra*, G.; *V. æquilateralis*, G.;—*Chione angulata*, G.; *Ch. varians*, G.;—*Meretrix* (= *Cytherea*) *lens*, G.; *M. Hornii*, G.; *M. longa*, G.; *M. arata*, G.; *M. ovalis*, G.; *M.?* *fragilis*, G.;—*Caryatis nitida*, G.;—*Dosinia elevata*, G.; ? *D. tenuis*, Meek; *D. pertenuis*, G.; *D. gyrata*, G.; *D. inflata*, G.;—*Tapes Conradiana*, G.; ? *T. quadrata*, G.; ? *T. cretacea*, G., and *Eriphyla umbonata*, Gabb.

182.—*Tapes Hilgardi*, Shum., (vide Gabb, l. cit., p. 265,) only provisionally referred to *Tapes*, is from Mexico.

183.—*Cyprimeria Peruviana*, Con., (Am. Jour. Conch., ii, p. 105,) from Peru.

184.—*V. (Auca) Aucasiana?* d'Orb., (Voy. Astr. Pal., 1847, pl. ii, figs. 9-10,) may be a *Callista*, a great deal resembling our Indian *C. fabulina*, n. sp. D'Orbigny seemed to have taken a peculiar fancy to the name *Auca*, and made in this and another instance great confusion with it. He describes in "Pal. de l'Am. merid. (1842)," p. 122, a *Tapes*-like shell as *V. auca*, supposed to be a tertiary fossil from Patagonia; subsequently, in 1847, he names quite a different shell, *V. auca*, in "Voy. de l'Astrolabe," and at last he quotes (Prod. ii, p. 237,) *V. Aucasiana*, adding the reference of the tertiary *V. Auca* in the Pal. Am. merid. No version of this confusion appears satisfactory. The most likely thing is, that d'Orbigny, wishing in the Prodrôme to correct the cretaceous species *V. Auca* of 1847, the name having been applied for a different species in 1842, quoted by mistake with it the reference of the latter instead of the former. This explanation would be strengthened by the fact that the name *V. Aucasiana* does not appear to have been published before, and is first used in the Prodrôme.

185.—*V. Chia*, d'Orb., (Pal. Am. merid., 1842, p. 82,) may be a *Caryatis*.

186.—*V. cretacea*, d'Orb., (ibid.) is "*ovato-compressa, antice brevi, postice angulata*"—sic!

187.—*V. Hallii*, Gabb, 1862, (olim *V. Orbignyana*, Gabb, non *id.* Forbes), Proc. Am. Ph. Soc., vol. viii, p. 235.

188.—*Cyprimeria spissa*, Conrad, (Am. Journ. Conch., v, [1869], p. 44), from New Jersey, (a very insufficient cast).

189.—*Gemma ? cretacea*, Conrad, (ibid. v, p. 96,) is from Mississippi.

Thetironia, (vide Catalogue des "*Thetis* connues," Pictet et Campiche in Pal. Suisse, 4^{me} ser., 3^{me} part., p. 209).

190-198.—*Thetis Renevieri*, *minor*, *laevigata*, *Prestensis*, *major*, *Genevensis*, *Sanctæ-crucis*, *Rotomagensis*, and *undulata*.

Corbula gigantea, Sow., often referred to *Thetironia*, is most likely a *Poromya*, and *Corbula laevigata*, Sow., suggested to belong to the same genus, will be noticed as the type of a new genus, *Fimbriella*, in the family LUCINIDÆ.

199.—? *Th. elongata*, Gabb, (Pal. Calif., ii, p. 186, pl. 30, fig. 80,) seems rather to have the form of a *Crassatella* than that of a *Thetironia*.

The following is the list of our South Indian cretaceous species.

200-210.—*Baroda* [*Icanotia* ?] *Pondicherriensis*, Forbes, sp., *Baroda* [*Icanotia*] *elicitæ*, Stol., *Cytherea plana*, Sow., *C. Garudana*, Stol., *C. Arcotensis*, Forb., sp., *C. lassula*, Stol., *Cyth.* [*Callista*] *solitaria*, Stol., *C. [Call.] sculpturata*, Stol., *C. [Call.] fabulina*, Stol., *C. [Call.] laciniata*, Stol., *C. [Call.] minutula*, Stol., *C. [Call.] vagrans*, Stol., *C. [Caryatis] turgidula*, Stol., *C. [Car.] Telugensis*, Stol., *C. [Car.] intercisa*, Stol., *Cyprimeria analoga*, Forbes, sp., *Cyp. Oldhamiana*, Stol., *Cyp. obesa*, d'Orb., sp., *Eriphyla lenticularis*, Goldf., sp., *Eriphyla Forbesiana*, Stol., *Er. diversa*, Stol.

Of doubtful species there are large numbers. Pictet and Campiche point out several, and many more could be added; but as I have not examined authentic specimens, and as the figures do not allow any better conclusions to be made than those upon record, I shall not notice them further, I may only mention the following—

Cytherea Herzogii, Hausmann, in Goldf. Petr. Germ., ii, p. 239, pl. 149, fig. 10. Judging from the general character of the shell and especially its strongly crenated internal margins, it is, I think, pretty certain that this species is an *Eriphyla*.

Venus perovalis, and also *V. Syriaca* and *indurata* of Conrad from Palæstine, are said by Fraas to be in a state hardly sufficient for determination (vide Würt. Nat. Jahreshfte, xxiii, 1867, p. 238).

Astarte ? discus, Sharpe, (Quart. Journ. Geol. Soc., Lond., vi, p. 177,) from Spain could be an *Eriphyla* with a flat strong shell, but the hinge is not known.

Ven. exularis, Keys., a little tumid oval species. Eichwald (Leth. Ross., livr. xi, 1867, p. 712,) supposes that this may rather be a neocomien than a jurassic shell.

Taking now a very general view of the characters of cretaceous species which are up to the present known, and supposing that only some of my suggestions are correct (—at least those in which I have examined the hinges, or of which good figures exist), we may be allowed to summarise the investigations regarding the representation of the VENERIDÆ in cretaceous rocks in the following words—

Of the TAPESINÆ we find only a few doubtful species belonging to *Pullastra*, *Hemitapes*, *Tapes*, and one species of *Amygdala*; on the other hand, many belong to the new genus *Baroda* and its sub-genus *Icanotia*; they are all in external

shape like *Psammocola* or *Psammobella*, most of them having been formerly described as *Psammobia* or *Solen*. In the *VENERINÆ* we hardly find a single species belonging to *Venus* as restricted, and scarcely any of the other subordinate forms, except perhaps *Mercenaria*, and one species may indicate a *Cryptogramma*. The *Cytherea* group are, on the contrary, largely represented. We find many species of *Cytherea* proper which is of general geographical range, apparently a great many species of *Callista* and a large number of *Caryatis*, especially in America; *Dione*, chiefly in America, where most of the recent species also occur at the present time, but hardly a single form occurs which could with any probability be referred to *Tivella*. Of the old *Circe* group, including *Lioconcha* and *Crista*, there is also scarcely a single species to be met with. Neither is there any distinct indication of the occurrence of species belonging to the *SUNETTINÆ*.

The *DOSINIINÆ* are found in large numbers and great variety, both with a solid and with a thin shell. To the latter belong the species of *Thetironia* (commonly known as *Thetis*), being the old representatives of the recent *Clementia*. One of the oldest cretaceous forms of the group with thicker shells is *Eriphyla*, but not yet sufficiently well known as to the number of species; it is decidedly a *Dosinia*-form, and not an *Astarte* or *Lucina*, under which name several species seem to have been described from jurassic and cretaceous rocks. Next comes *Cyprimeria*, which also greatly recalls *Dosinia*, while of this last genus proper there are as yet no species sufficiently ascertained. Of *Gemma* there may be one or two species, but these also are not certain.

These general results will, I trust, also indicate how far we are justified in attaching importance to the various genera and sub-genera pointed out in the preceding pages.

BARODA, *Stoliczka*, 1870, (vide p. 145).

1. BARODA [ICANOTIA] PONDICHERRIENSIS, *Forbes*, sp., Pl. IV, Fig. 5 ;
Pl. XVII, Fig. 4.

1846. *Tellina* ? *Pondicherriensis*, *Forbes*, Trans., Geol. Soc., Lond., vii, p. 142, pl. xviii, fig. 5—*idem* auctorum.

Baroda testa elongata, compressa, antice ac postice rotundata, valde inæquilaterale, margine inferiore et superiore fere parallelis, umbonibus parvulis, acutis, paulo prominulis; superficie striis crassis concentricis ac lineis radiantibus sub-obsoletis notata. Cardo valvulæ dextræ dentibus cardinalibus tribus, duobus anterioribus brevibus, postico elongato, omninisque tenuibus, compressiusculis instructus.

Height	:	length	...	...	...	...	0.47
Thickness	:	height	...	...	...	...	0.57

The shell of this species is rather thick, covered with broad and rather strong striæ or ribbings, and a number of very fine radiating, mostly obsolete lines. These

striae are partially traceable on an imperfect specimen in our collection (pl. xvii, fig. 4), but I have not been able to see them on Forbes' original, of which I have also given a view. On the former, the hinge-teeth of the right valve were observed, though on account of the difficulty in preparation they became somewhat less distinct.

For the sake of comparison, and also in order to illustrate the hinge of *Baroda* and its sub-genus *Icanotia*, I have given a view of the hinge of *Baroda* [*Icanotia*] *impar*, Zittel, sp., on p. xvii, fig. 5. It would be very interesting to examine more perfect specimens of this species.

Locality.—Moraviatoor, in a dark earthy limestone; apparently rare.

Formation.—Ootatoor group.

✓ 2. BARODA [ICANOTIA] ELICITA, *Stoliczka*, Pl. IV, Fig. 16.

Bar. testa perlonga, valde compressa et inæquilaterali; parte anteriori brevi, ad terminationem angustatim rotundata, postice oblique ac late sub-truncata; umbonibus parvulis, declivitate lunulari rectiuscula, areali fere concaviuscula, perlonga; margine ventrali levissime curvato; superficie liris depressis latiusculis, concentricis ac costulis radiantibus tenuibus, confertis, imprimis in parte postica distinctis, notata.

Median height	:	length	...	...	...	...	0.34
Thickness	:	height	...	...	...	...	0.64

This species closely resembles the one described by Zittel from the Gosau deposits, *B.* [*Icanotia*] *impar*, but the posterior end is more truncated, and the radiating ribs finer; the latter character easily distinguishes also the Indian fossil from any of the forms photographed by Guéranger. The hinge-teeth must be very thin and small. I have not been able to trace them on any of the two specimens in our collection, with the exception of a thickened margin seen internally along the lunula, such as I have, however, not observed in any of the other species of *Icanotia*.

Locality.—North of Karapaudy, in a whitish, highly calcareous sandstone; apparently rare.

Formation.—Arrialoor group.

CYTHEREA, *Lamarck*, 1807, (vide p. 150).(P SUB-GENUS *Dosiniopsis*, *Conrad*, 1864), (vide p. 151).✓ 1. CYTHEREA PLANA, *Sowerby*, sp., Pl. VII, Figs. 1-4.

1812. *Venus plana*, *Sowerby*, Min. Conch., vol. i, p. 58, pl. xx, lower figure.
 " ? " *lineolata*, " " " p. 57, " upper "
 1839. ? *Cytherea plana*, *Goldfuss*, Petr. Germaniæ, pt. ii, p. 138, pl. 148, fig. 4.
 1843. ? *Venus plana*, *Sowerby*, d'Orbigny, Pal. franç. terr. cret., vol. iii, p. 447, pl. 386, figs. 1-3.
 1847. ? *V. plana*, *Sow.*, Müller, Petr. Aach. Kreidef., pt. i, p. 25.
 1850. ? *Venus sub-plana*, d'Orb., Prod. ii, p. 237—*idem*, Pictet, Bosquet, &c.
 1867. *Venus plana*, *Sow.*, Guéranger, Album paléont. de la Sarthe, pl. xvii, fig. 11.

Cyth. testa oblonga, inæquilaterali, antice rotundata, moderate producta, postice sub-truncata, declivitate superiori antica paulo excavata, postica longiore ac convexiuscula ad terminationem anticam rotundata, ad posticam subtruncata; umbonibus prominulis, antice versus paulo incurvis; valvis moderate convexis, seu applanatis, striis concentricis incrementi tenuibus ac alteris crassioribus instructis; lunula longa, cordiformi, paululum excavata seu convexiuscula, linea impressa tenui circumscripta; cardo in utraque valva dentibus tribus cardinalibus posticis bifurcatis instructus, dente lunulari in valva dextra tenui margini lunulari parallelo, et excavationi profundæ in valva sinistra sitæ congruente.

Length of largest specimen	...	...	...	66 m. m.
Height " "	...	...	...	56 "
Thickness " "	...	...	...	21 "
Height : length	...	...	...	0·84 to 0·91
Thickness : height	...	...	...	0·37 to 0·50

The form of this shell entirely agrees with that of the recent *Cythereæ*; it is generally rather less inflated than these, but besides the usual striæ of growth there is no other ornamentation present. The convexity, length, height, and thickness are subject to slight variations which are, however, not very considerable. The beaks are rather prominent, close together, and slightly incurved, the upper anterior slope being slightly excavated, the posterior convex and considerably longer than the former; the posterior end is somewhat narrowly truncated, while the anterior one is rounded and more or less produced. These variations are to be observed equally clearly in our own specimens, as in those from Blackdown, and for this reason I greatly suspect that *Sowerby's V. lineolata* is not distinct from the present species, as already alluded to (p. 160). The inner edge of the shell is, as usually, smooth, the pallial sinus about as deep as in the recent *Cyth. attenuata*, *Dunk.*, slightly more angular at the end; the fulcra supporting the ligament are thick and long. The hinge exposes three cardinal teeth of the usual form, the posterior is deeply grooved; the lunular tooth is thin, and about parallel to the lunular margin, upon which peculiarity *Conrad* proposes a special sub-genus *Dosiniopsis*. This seems to me, however, only to indicate a wish to satisfy that author's curious idea, that all the cretaceous species belong to genera distinct from those to which tertiary or recent species are referable.

I have not seen any of the original specimens referred by d'Orbigny to this species in his "Pal. française," but I saw others fully as short and high as the one figured by Goldfuss. His figure shows the lunular edge very prominent; some specimens approach to it in this respect, but I have not seen any with an equally strongly projecting lunula. Some of our specimens also perfectly correspond with the two photographs given by Guéranger. The form figured by Reuss (in Böhm. Kreidef., pl. xli, fig. 14,) has the anterior side very much produced, and if the outline of the posterior end is correct, I would think that it hardly could belong to the present species. Our specimens are certainly undistinguishable by any prominent character from those occurring at Blackdown from which Sowerby obtained his originals: both exhibit the same amount of variations as already stated.

Localities.—North of Alundanapooram and north of Kunanore, in a yellowish brown conglomeratic sandstone.

Formation.—? Trichinopoly group, but very close to the boundary of the Arriallor, with which the mineralogical character of the rock corresponds rather better than with that of the former. In Europe the shell appears to be characteristic of the Upper Greensand and Senonien (Plæner) beds of the continent.

✓ 2. CYTHEREA GARUDANA, *Stoliczka*, Pl. VI, Figs. 17-19.

Cyth. testa regulariter oblonga, sub-inæquilaterali, crassiuscula, ad utramque terminationem sub-rotundata, compressiuscula imprimis in senioribus speciminibus; superficie striis concentricis prope marginem exteriorem crassioribus, ac sulcis latiusculis notata; umbonibus acutis, paulo incurvis, declivitatibus superioribus subrectis, antica paululum concava, postica convexiuscula; dentibus cardinis sicut in Cyth. plana dispositis; lunula angusta longa, linea impressa circumscripta.

Length of largest specimen	...	...	...	...	45 m. m.
Height : length...	...	...	...	...	0.70-0.74
Thickness : height	...	...	...	...	0.40-0.46

Shell nearly regularly oval, rounded anteriorly and posteriorly, with the beaks somewhat prominent and incurved towards the anterior end; the surface is covered with striae of growth only, these being stronger near the margins and partially alternating with broadish shallow sulci; the lunule is very long, narrow, cordiform, along its central line somewhat sharply elevated, and all round margined by a fine groove. The hinge does not differ in any essential way from that of *Cyth. plana*, except that the lunular tooth of the left valve is proportionately somewhat stronger, though the corresponding cavity of the left is not peculiarly deep and not marked by such strongly elevated edges as in the former species; the cardinal teeth of the right valve are all more or less distinctly bifid. The pallial sinus has not been observed. The oval and compressed form readily distinguish this from the former species, and also from *Cyth. Archiaciana*, to which it appears still more related.

Locality.—Comarapolliam, in a greyish sandstone.

Formation.—Arriallor group.

✓ 3. CYTHEREA ARCOTENSIS, Forbes, sp., Pl. XVI, Fig. 34.

1846. *Venus Arcotensis*, Forbes, Trans., Geol. Soc., London, vii, p. 146, pl. xv, fig. 19.1850. *Astarte id.*, d'Orbigny, Prod. ii, p. 238.

"*Testa orbiculari, subobliqua, inæquilaterali, plus minusve convexa, polita concentrice striata, striis confertis irregularibus, margine lævi, umbonibus prominentibus, lunula minuta.*" (Forbes loc. cit.).

Such is the account of this species given by Forbes. I cannot identify it with any of our Indian shells, and, therefore, reproduce his figure. It is a remarkably orbicular form. I examined the original specimen in London, and find in my notebook the only remark, "figure of Forbes good; it is not an *Astarte*, as suggested by d'Orbigny, but a *Cytherea*, with three cardinal and one lunular tooth in the left valve, the last not very oblique and with its base close to the most anterior cardinal." I thought that the species could be *Cyth. plana*, but the form does not at all agree with it; nor could it be *Cyprimeria Oldhamiana*, which has nothing like what could be mistaken for a lunular tooth in the left valve. It is to be hoped that further discoveries will elucidate this point. The only species remaining with which it could be compared are those of the *Circe* group.

"*Locality.*—Trichinopoly."

✓ 4. CYTHEREA LASSULA, Stoliczka, Pl. VII, Figs. 10-17.

Cyth. testa elongato-ovata, tumescente, umbonibus prominulis, acutis, approximatis et paululum incurvis instructa, antice rotundata, postice angustatim truncatula; declivitate superiori antica (seu lunulari) brevi, moderate excavata, postica (seu areali) longiori, convexiuscula; margine inferiori convexo, versus terminationem posticam paululum insinuato; superficie striis concentricis sulcis nonnullis latioribus interpositis notata, striis minutis aliquando obsoletis; lunula ovato-elongata, antice acuta, linea impressa marginata, fere plana. Cardo in utraque valva dentibus cardinalibus plus minusve distincter furcatis (imprimis dent. posticis) instructus; dente lunulari in val. sinistra tenui, elongato, margini lunulari parallelo, in valva dextra fossæ elongatæ supra ac infra crassiuscule marginatæ congruente; sinu pallii brevi, obtuso, ascendente.

Length of the largest specimen	...	...	...	36 m. m.
Height : length	...	...	...	0.77-0.83
Thickness : height	...	...	...	0.60-0.64

Shell elongated, ovoid, rather tumid and strong, covered with fine concentric striæ, which in places, especially towards the margin, alternate with broad sulci; sometimes the finer striæ become quite obsolete, but this is likely only due to the preservation of the surface. The beaks are prominent, pointed, close together and slightly incurved towards the long, elliptical lunule, which is very little raised or flat, but margined with a deep line. The lunular margin is slightly concave, the

areal convex, with the edge bent in, so as to make the ligament less prominent than is often the case in other species. The anterior end is rounded and the posterior somewhat narrowly truncated, the inferior margin being a little flexuous towards the posterior end. Specimens are, however, occasionally met with with a more regularly oval form (see fig. 11). The hinge is similar to that in the species previously noted. The posterior cardinals are in both valves deeply grooved, and the lunular of the left valve is much elongated. The pallial sinus is short, obtuse, and ascending, slightly larger than in *Cyth. Rotomagensis*, d'Orb., to which our species also bears some resemblance. The form is entirely that of a *Cytherea* of the concentrically ribbed or striated type (like *Cyth. lirata*, Sow.), while the *Callistæ* mostly are flatter, though it is really difficult to fix a proper limit in such cases.

Localities.—North of Kunanore, north-east of Karapaudy, in a light greyish soft sandstone.

Formation.—Arriallor group.

✓ 5. CYTHEREA [? CALLISTA] SOLITARIA, *Stoliczka*, Pl. V, Fig. 20.

Cyth. testa elongate elliptica, valde inæquilaterali, moderate convexiuscula, antice breviter et late rotundata, postice sub-truncata; declivitate lunulare et areale aut convexiusculis, aut prima applanata, altera convexa et intus furcata, extus obtusiuscula; margine ventrale fere recto, levissime curvato; superficie striis subtilissimis et nonnullis liris sub-obsoletis imprimis prope umbonem distinctis notata; umbone valde incurvo, acuto; lunula haud distincter marginata, medio elevata. Cardo in valva sinistra dentibus cardinalibus tribus, tenuibus, postico perlongo, duobus alteris multo brevioribus et dente lunulare lamelliforme, fossa profunda ab margine lunulare separato instructus.

Height of the right valve	:	its length	...	...	...	0.69
Thickness (supposed) of both valves	:	height	...	...	...	0.55

This is a remarkable shell and undoubtedly belongs to the type of *Callista*, which is represented among recent shells by *Cyth. gigantea*, Chem., and of which I have already (p. 150) stated that it may probably form a distinct sub-genus together with a few other known forms. The posterior cardinal tooth is very elongated and the two others are small; this character greatly resembles *Baroda* of the *TAPESINÆ*, but the strong lunular tooth is wanting in that sub-family. In our species the lunular tooth of the left valve is strong, lamelliform, and separated by a broad and deep groove from the lunular margin itself. The form of the fossil shell is also peculiarly elongated, like that of *Baroda*; the surface is concentrically finely striated, but there are some broadish sulci to be observed near the strongly incurved umbo.

The fact, that the two sections of *Callista* are represented in cretaceous rocks, and that the usual lirate species are here already much more numerous than those

of the type of *Cyth. gigantea*, appears to support the suggestion of their belonging to distinct sub-genera.

Locality.—South of Garudamungalum, in a brownish calcareous sandstone full of little shells; only the figured left valve has as yet been found.

Formation.—Trichinopoly group.

✓ 6. CYTHEREA [CALLISTA] SCULPTURATA, *Stoliczka*, Pl. VII, Figs. 7-9.

Cyth. testa ovata, antice rotundata, postice sub-truncata; declivitate lunulare paululum concava, areale convexiuscula, crassa, inflexa, supra marginibus obtusiusculis instructa; lunula elongata angusta, medio paulo elevata, antice acuta, linea impressa marginata; margine ventrale moderate ac uniforme curvato; valvis moderate convexiusculis, concentricis liratis, liris crassis sulcis profundis angustisque separatis, prope umbones obsoletis; umbonibus approximatis paululum antice versus incurvis, acutis. Cardo in valva sinistra dentibus tribus cardinalibus, sub-æqualibus et unico elongato lunulare instructus; fulcris tenuibus sub margine areale obtuso sitis; sinu pallii?

Length of largest specimen	...	...	...	...	50 m. m.
Height : length	...	...	...	...	0.74
Thickness : height	...	...	...	...	0.60

This species belongs to a type of *Callistæ*, mostly peculiar to the eastern seas, and represented by the well known *C. erycina*, Linn., which occurs already in the miocene deposits of Europe, and is one of the commonest species on the eastern coast of Ceylon. As compared with this species the form of our fossil is shorter, the concentric ribs are less flattened, though almost equally strong in both species, and the interspaces narrow and deep; towards the umbones the ribs become obsolete. The area is deep and externally margined by elevated obtusely rounded edges; the fulcræ are rather thin and deeply situated. In other respects the Trichinopoly fossil does not offer any peculiarities. It is extremely interesting to find this type of *Callistæ* already represented during the cretaceous period in the same regions where the recent forms occur. A very similar form also occurs in the tertiary deposits of Burma. Such instances cannot fail to be of the greatest importance in tracing out the geographical distribution of animal life during progressive periods of time.

Locality.—Neighbourhood of Kunanore, in a conglomeratic sandstone.

Formation.—Arriallor group.

✓ 7. CYTHEREA [CALLISTA] FABULINA, *Stoliczka*, Pl. XVI, Figs. 31-33.

Cyth. testa ovato elongata, inæquilaterale, umbonibus prominulis, acutiusculis, incurvis ac approximatis instructa, declivitate lunulare fere recta, areale convexiuscula, lunula elongata, antice acuta, linea impressa marginata, medio elevata; area angustissima, paululum profunda; terminatione anteriori rotundata, posteriori rotundate truncata; margine ventrale uniforme curvato; valvis moderate convexis in superficie confertissime liratis, liris crassiusculis, obtusiusculis, interspatiis profundis, vix angustioribus, intersectis. Cardo in valva dextra dentibus tribus cardinalibus, longis, tenuibus instructus, dente postico furcato; fossa lunulari elongata, angustata; fulcris tenuibus.

Length of largest specimen	...	...	...	23 m. m.
Height : length	...	...	...	0.72 - 0.79
Thickness : height	...	...	...	0.51 - 0.53

The numerous very distinct and very regular concentric ribs give this shell quite an elegant appearance; it greatly resembles d'Orbigny's *V. sub-fava*, described and figured in the Pal. Française under Sowerby's name *V. fava*, which is, however, a more regularly elliptical shell with finer striation. D'Orbigny's figure also represents a slightly higher shell with a more oblique terminal declivity posteriorly than seen in our Indian form. In this the lunula is oval, pointed in front, elevated in the median line and margined by a deep groove; the area is very narrow and slightly excavated. The hinge-teeth of the right valve are rather elongated, thin, the posterior being distinctly grooved; the lunular pit is narrow, somewhat elongated, with a more strongly raised edge below than above; the fulcra are very thin and situated at the base of the area, but are considerably shorter than this one.

Localities.—Garudamungalum, (one specimen), in a bluish calcareous sandstone full of little shells; east of Odium, (four specimens), in a dark brown calcareous rock, also with small shells.

Formations.—Trichinopoly and Ootatoor groups.

✓ 8. CYTHEREA [CALLISTA] LACINIATA, *Stoliczka*, Pl. VII, Figs. 5-6.

Cyth. testa oblonga seu sub-quadrangulare, paulo longiori quam alta, inæquilaterali, convexiuscula, antice breviter et late—postice paululum anguste ac oblique truncatim rotundata; margine ventrali leviter convexiusculo; umbonibus prominulis, approximatis, sublævigatis; declivitate lunulare precipita, subrecta; lunula angusta, depressione lineali indistincta marginata; declivitate areali convexiuscula, area angusta, profunda; cardo in valva dextra dentibus tribus cardinalibus, medio crassissimo et dente lunulari elongato instructus; superficie liris crassis, obtusiusculis, sulcis angustioribus profundis separatis, notata.

Length of largest specimen	...	...	...	20 m. m.
Height : length	...	...	...	0.78 - 0.82
Thickness : height	...	...	...	0.59 - 0.61

This small species is well characterised by its great height in proportion to its length, its form being either broadly oval or sub-quadrangular, the beaks are as

usually prominent and pointed; the concentric ribs are comparatively strong; the lunula is very narrow, only indistinctly marked by a shallow depression; the area is also narrow, but deep. The hinge-teeth offer no peculiarity; they are short, and the middle one of the three cardinals is the thickest; the lunular tooth is elongated. This species bears some resemblance to Forbes' *Venus Arcotensis* (*Cytherea*), but the ornamentation is totally different.

Locality.—Ninnyoor, in a white earthy limestone.

Formation.—Arrialoore group.

✓ 9. CYTHEREA [CALLISTA] DISCOIDALIS, *Stoliczka*, Pl. VII, Figs. 30-31.

Cyth. testa late seu rotundate ovata, antice ac infra rotundata, postice angustatim sub-truncata; declivitate lunulare concaviuscula, areale moderate curvata; lunula parva, angusta, impressa; area longa, angusta, excavata, marginibus acutis circumdata; fulcris longis, crassis sed profunde sitis; valvis moderate convexiusculis, sub-discoidalibus, liris crassiusculis ac interspatiis sub-latis profundis separatis omnino notata. Cardo dentibus tribus cardinalibus, brevibus, in utraque valva crassis instructus; dente lunulare elongato.

Length of largest specimen	...	...	...	...	24 m. m.
Height : length	...	...	...	...	0·87
Thickness : height	...	...	...	...	0·60

The more flattened, roundish, and almost discoidal shape of this species readily distinguishes it from the last. The concentric ribs are strong and the interspaces broad, though not as broad as the ribs.

Locality.—Ninnyoor, in a whitish, earthy, and in a conglomeratic limestone.

Formation.—Arrialoore group.

✓ 10. CYTHEREA [CALLISTA] MINUTULA, *Stoliczka*, Pl. VII, Figs. 18-20.

Cyth. testa late ovata, compressiuscula, prope umbones tumescente, sub-inæquilaterali, antice rotundata, postice angustatim truncatula; declivitate lunulare concaviuscula, areale convexa, ad marginem ventralem regulariter convexa; concentrice eleganter lirata: liris crassis plus minusve obtusis et sulcis æquidistantibus seu interdum latioribus atque subtilissime striatis separatis. Cardo dentibus cardinalibus tribus in utraque valva, duobus anticis brevibus, crassiusculis, furcatis, postico tenui elongato, et dente lunulare in valva sinistra mediocri, ab ceteris distantiori, fossæ profundæ in valva dextra congruente instructus.

Length of largest specimen	...	...	...	...	11·5 m. m.
Height : length	...	...	...	...	0·79
Thickness : height	...	...	...	...	0·52

This is a very elegant, small, and rather compressed shell, more or less broadly oval, anteriorly rounded, posteriorly slightly and narrowly truncated; only near the beaks the valves are a little more tumescent, flattening out very gradually, so much so that larger specimens would no doubt have the appearance of very flat

shells. In well preserved specimens the concentric ribs are thinner as compared with the interspaces in which extremely fine concentric lines are traceable. When, however, the ridges of the ribs are a little worn off and thus become broader, the interspaces have apparently the same width as the ribs.

Locality.—Comarapolliam, in a light grey sandstone, apparently rare; only three specimens were as yet found; all are figured.

Formation.—Arrialoor group.

✓ 11. CYTHEREA [CALLISTA] VAGRANS, *Stoliczka*, Pl. VII, Figs. 21-23.

Cyth. testa late ovata, seu rotundate quadrangulari, moderate convexiuscula, concentricis liris subtilibus numerosissimis sulcis angustis parum profundis separatis notata; declivitate lunulare fere recta, areale convexiuscula; lunula magna, ovata linea impressa marginata, medio elevata; area minima impressa; margine antico, ventrale ac postico uniforme—, ultimo quandoqu岸 levissime— arcuato; sinu pallii angusto, obtusiusculo, ascendente. Cardo in valva sinistra dentibus tribus cardinalibus et uno margine lunulari parallelo instructus; dentibus cardinalibus duobus posticis in valva dextra ceteris multo crassioribus.

Length of largest specimen	...	...	...	...	14 m. m.
Height : length	...	...	...	...	0.75
Thickness : height	...	...	...	...	0.66

Shell ovate or sub-quadrangular, small, moderately convex, with very numerous, close concentric not much elevated ribs; beaks prominent, pointed, and incurved; lunular declivity almost straight, with the lunula ovate, proportionately large, margined by a distinct groove and elevated along the central line; posterior declivity convex, the area very short, narrow and impressed, with the fulcra hardly distinguishable; anterior and posterior ends rounded, the former slightly produced; ventral margin more convex in the oval than in the sub-quadrangular forms; pallial sinus short, narrow, obtuse at the end and ascending. In the left valve the cardinal teeth are thin, except the anterior, which is a little thicker than the rest; the lunular tooth is elongated and parallel to the margin. In the right valve (a specimen from Comarapolliam) the two posterior cardinals are remarkably thick, leaving narrow interspaces between them for the thinner teeth of the left valve.

Localities.—Comarapolliam and north-east of Karapaudy, in whitish conglomeratic sandstone (one specimen from each); Garudamungalum in bluish calcareous sandstone (two specimens); south of Garudamungalum in brownish sandstone (one specimen).

Formation.—Arrialoor and Trichinopoly groups. The Comarapolliam specimen is somewhat roundly sub-quadrangular, and has the two posterior cardinals, as noticed above, remarkably thick, but there is no other difference in the ornamentation and structure of the shell. The specimen from Karapaudy is in every respect identical with those from Garudamungalum, and is the largest.

✓ 12. CYTHEREA [CARYATIS] TURGIDULA, *Stoliczka*, Pl. VII, Figs. 24-27.

Cyth. rotundate ovata, turgidula, polita, concentrice striato-lirata; liris ac striis prope umbones obsoletis; declivitate lunulare paulo excavata, areale convexa; lunula elongato elliptica, linea impressa marginata, medio paululum elevata; area latiuscula, brevi, paulo excavata, exterius haud marginata; margine ventrale uniforme curvato. Cardo in valva sinistra dentibus tribus cardinalibus ac uno lunulare distante instructus.

Length of largest specimen	...	...	...	...	15 m. m.
Height : length	...	...	...	...	0.84 - 0.88
Thickness : height	...	...	...	...	0.72 - 0.75

The more oval and comparatively more tumid form of the present species readily distinguishes it from *Cyth. [Caryat.] Telugensis*, n. sp. Young specimens are almost perfectly smooth with a polished surface, but on the larger one concentric striæ, gradually becoming stronger towards the ventral edge, are clearly traceable. The hinge-teeth are characteristic of those of other recent species of *Caryatis*, amongst which *C. Manillæ* may be mentioned.

Fig. 24 represents a somewhat more tumid variety with a little more distinct concentric sulcations, but the shell certainly belongs to the same species, though it would appear to have the anterior end shorter than others; this is, however, not quite perfect in the original. This specimen is from a calcareous dark grey sandstone from east of Odium. Another similar specimen is from a white limestone; it does not show on the well preserved shell the striæ very strong, and they become perfectly obsolete near the apex.

The lunula is large, elongately elliptical, the area indistinctly marked, and somewhat excavated.

Locality.—Neighbourhood of Odium, in a blackish or greyish highly calcareous sandstone and in a whitish limestone.

Formation.—Ootatoor group.

✓ 13. CYTHEREA [CARYATIS] TELUGENSIS, Pl. VII, Figs. 28-29.

Cyth. testa sub-triangulari, altissima, convexiuscula, inæquilaterali, antice breviter rotundata postice longiori; umbonibus valde prominulis, attenuatis, incurvis et approximatis; declivitate lunulare moderate excavata, areale paululum curvata; lunula longa, elliptica, linea impressa marginata, vix concaviuscula; area haud distincte marginata; margine ventrale uniforme curvato; in superficie striis crassiusculis, numerosissimis, interdum sulcis duobus aut tribus ad intervalla positae et interruptis notata. Cardo in valva sinistra dentibus tribus cardinalibus, postico tenui elongato, duobus alteris brevibus crassiusculis, divergentibus, et dente lunulare parvulo instructus.

Length of largest specimen	...	...	...	...	18 m. m.
Height : length	...	...	...	...	0.91
Thickness : height	...	...	...	...	0.60

This species is a typical *Caryatis*, with almost uniformly convex valves, and covered with rather fine concentric striæ; the thin longish posterior cardinal corres-

ponds to a thick grooved one in the right valve, and the two anterior cardinals are somewhat diverging, short and stout; the lunular tooth is also small, as in the recent species of *Caryatis*. The striation in fig. 29 has been made accidentally a little too strong as compared with the size of the shell.

Localities.—Comarapolliam, in a whitish soft sandstone (one specimen); Garudamungalum, in a dark grey calcareous shell-sandstone (two specimens). These three specimens from the two localities are perfectly identical; it is evidently a rare shell.

Formation.—Arrialore and Trichinopoly groups.

✓ 14. CYTHEREA [CARYATIS] INTERCISA, *Stoliczka*, Pl. VIII, Figs. 1-2.

Cyth. testa sub-quadrangulariter ovulata, tumida, crassa, concentrice striata, antice ac postice truncatim rotundata, ad marginem ventralem leviter convexa; umbo-nibus paulo prominulis, parvis, obtusiusculis, approximatis; declivitate antica paulo excavata, postica fere recta, deinde sub-rotundata; superficie in specimine majori laciniatim seu lamellose concentrice striata; lunula parva, ovata, medio elevata, linea impressa marginata; area angusta, paulo excavata, extus haud marginata; dente lunulare ab dentibus cardinalibus remote sito.

Length of largest specimen	...	...	...	...	about 45 m. m.
Height : length	...	...	...	...	0.88
Thickness : height	...	...	...	...	0.80

Of the two specimens found one is small and the other considerably larger; on the former the shell surface is partially preserved in its original state, exhibiting fine concentric striæ; on the second the striæ, where seen, are lamellar and thin, but the shell surface is partially worn off and partially the shell is removed altogether. The form is very characteristic, almost of a quadrangular shape with rounded edges, though if the shell was well preserved, the form would no doubt be more distinctly rounded or broadly oval. The thickness is great, such as is not often to be met with in recent species of *Caryatis*. The cardinal teeth are not visible, but the impression of the remote lunular tooth is traceable.

Localities.—North-west of Kunanore and north of Alundanapooram, in a brownish sandstone with numerous minute, brown oolitic grains; apparently rare.

Formation.—Trichinopoly group.

CYPRIMERIA, *Conrad*, 1864, (vide p. 157).

✓ 1. CYPRIMERIA ANALOGA, *Forbes*, sp., Pl. V, Figs. 21-23.

1846. *Venus analoga et eximia*, *Forbes*, Trans., Geol. Soc., Lond., vii, p. 147, pl. xv, figs. 20-21.

1850. *Venus analoga*, *Forbes*, d'Orbigny, Prod. ii, p. 237,—*idem* auctorum.

Cyp. testa late-ovata, compressiuscula, antice paulo producta, rotundata, postice rotundate sub-truncata, ad marginem ventralem leviter curvata, marginibus undique

attenuatis; declivitate antica infra umbones parvulis adpressis paululum excavata, deinde uniforme in convexitate marginis anterioris transeunte; declivitate postica fere recta, levissime curvata et cum terminatione postica angulum obtusum formante; lunula haud distincta; area longa, profunda; fulcris crassis et ligamento prominente; sinu pallii angusto, rapide ascendente, apice obtuse acutiusculo; superficie striis subtilibus numerosissimis ac nonnullis sulcis magis profundis sed non precipue latis tecta.

Length of largest specimen	...	...	...	...	54 m. m.
Height : length	...	...	...	...	0·80
Thickness : height	...	...	...	...	0·43

Shell elongately and broadly ovate, rather compressed, thickest about the middle, and sloping regularly towards the attenuated and sharp margins (except near the area), and also towards the beaks which are somewhat depressed and very close together. There is no special lunula, but the lunular region is slightly concave below the beaks, passing immediately into the curve of the somewhat produced anterior end; the ventral margin is also slightly curved and the area still less so, the latter forming thick obtuse edges along the extended area; the posterior end is broadly and somewhat roundly truncated. The surface of the shell is covered with concentric striæ, among which some are stronger than others, but the intermixed sulci are not particularly broad. The pallial sinus when compared with that of the next species is narrower, slightly longer, and more rapidly ascending.

Localities.—East and south-east of Anapady, north of Alundanapooram, and south-east of Arrialoor, in a brownish, or (at the last loc.) in a whitish sandstone; rare.

Formations.—Trichinopoly and Arrialoor groups (only one specimen from the latter).

✓ 2. CYPRIMERIA OLDHAMIANA, *Stoliczka*, Pl. V, Figs. 24-25, and Pl. VI, Figs. 1-5.

Cyp. testa fere orbiculata, undique ad margines rotundata, declivitate lunulare infra umbones paululum concaviuscula, declivitate areale moderate curvata; umbonibus parvis, acutis et approximatis; lunula haud marginata; area longa, marginibus sub-acutis ac fulcris crassis vix prominentibus instructa; valvis in medio convexis atque margines versus undique declivis, concentrice regulariter ac confertim striolatis, striis sulcis latioribus nonnullis ad intervalla interruptis. Cardo in valva dextra duobus dentibus cardinalibus divergentibus penitus divisis, in valva sinistra tribus, dente postico tenui, fossa lata ab alteris duobus anterioribus compressis ac valde prominentibus separato, instructus; sinu pallii profundo, latiusculo, oblique ascendente.

Length of largest specimen	...	...	...	...	56·5 m. m.
Height : length	...	...	...	...	0·90 - 0·95
Thickness : height	...	...	...	...	0·43 - 0·49

This is one of the finest shells occurring in the South Indian cretaceous deposits. Its rounded discoidal form, with slightly prominent umbones, thickest

in the middle and gradually sloping towards all the margins, the regular striation intersected by a few deeper sulci are all most characteristic, readily distinguishing it from the last species. The pallial sinus is deep, rather rapidly and obliquely ascending from the infero-posterior end upwards. The hinge is typical of the genus. The right valve has two diverging perfectly divided cardinal teeth; the left two compressed very prominent anterior cardinals and one thin posterior, separated from the former by a broad but along the centre again somewhat raised groove; this posterior tooth is connected with the broad and thick fulcrum. There is no trace of a lunular tooth, though that portion of the margin is broad, but it is slightly excavated in both valves.

The common European *Cyp. discus*, Math., is more compressed, and has the beaks almost always remarkably flattened.

Localities.—Anapady, north of Alundanapooram and Garudamungalum, in a brownish, whitish, or bluish calcareous sandstone; not rare.

Formation.—Trichinopoly group.

✓ 3. CYPRIMERIA OBESA, d'Orbigny, sp., Pl. XVII, Figs. 1-2.

1847. *Lucina obesa*, d'Orbigny, Paléont. Voy. l'Astrolabe, pl. v, figs. 26-28.

Cyp. testa quadrangulariter rotundata, valde inflata, concentrice striis numerosis subtilissimis ac sulcis latioribus ad intervalla interpositis notata; umbonibus obtusiusculis, paulo prominulis, incurvis; regione lunulare infra umbones vix excavato, declivitate areale fere rectiuscula, marginibus ceteris uniforme curvatis; area brevi, angustissima; cardo in valva dextra duobus dentibus divergentibus omnino divisus, postico multo crassiore instructus.

Specimen figured on pl. xvii, fig. 1.				Specimen figured by d'Orbigny, pl. xvii, fig. 2.			
Height	:	length	... 0.88	Height	:	length	... 0.93
Thickness	:	height	... 0.72	Thickness	:	height	... 0.78

D'Orbigny gives an enlarged figure of a small specimen, but it evidently represents the same species as the one here described, though the roundness and thickness are slightly larger, which, however, is not unusual in young shells, their convexity generally becoming less prominent as they grow in size. The only right valve which we possess is apparently a little less tumid, because the surface is just in the place of the greatest convexity slightly worn off. The two diverging teeth of the right valve are perfectly divided, and the posterior tooth is thicker than the anterior, which is also somewhat less indistinctly traceable; the lunula is, as usual in *Cyprimeria*, not margined, and the area is small and very narrow.

Locality.—Ninnyoor, in white limestone; apparently very rare.

Formation.—Arrialoore group.

ERIPHYLA, Gabb, 1864, (vide p. 156).

✓ 1. ERIPHYLA LENTICULARIS, Goldf., sp., Pl. VI, Figs. 7-13.

1839. *Lucina lenticularis*, Goldfuss, Petr. Germ., p. 228, pl. 146, fig. 16; *idem*, Müller, Römer, Geinitz d'Orbigny, &c.

1865. *Artemis lenticularis*, Bosquet in Staring's Bodem v. Nederland, II^{de} deel; non *idem* Forbes (vide p. 182). Geinitz (Quadersandst., p. 158,) following Reuss, &c., identifies *L. lens* and *Reichii*, Römer, *L. circularis* and *V. parva*, Gein., with the present species; in most cases this would appear to be correct, but not being in possession of authentic specimens, or of the originals, it would be a vain task to speculate on this point.

Eriph. testa sub-quadrangulariter orbiculata, plus minusve compressa, interdum convexiuscula, umbonibus prominulis, acutis, incurvis; declivitate lunulare concava, areale moderate curvata; marginibus ceteris uniforme convexis; lunula atque area profundis, marginibus acutis elevatisque instructis, prima parva, altera longa et angustata; superficie striis subtilibus regularibus ac sulcis angustis interdum numerosis ad intervalla notata; sinu pallii parvo, latiusculo, obtusato. Cardo in utraque valva duobus dentibus cardinalibus quorum anteriori in valva sinistra et posteriori in valva dextra altero crassiori, et dente lunulare in valva sinistra elongato sub-obsoleto, fossa in valva dextra et denticulo elongato postico laterale remoto fossæ in valva sinistra congruenti instructus; fulcris latis, crassiusculis, haud prominulis.

Length of largest specimen	...	...	...	...	35 m. m.
Height : length	...	...	...	...	0.98 - 1.25
Thickness : height	...	...	...	...	0.37 - 0.46

It is scarcely necessary to add anything to the description of this well known species. The shell varies a little in form, but it is always more or less orbicular, sometimes with an indication of a quadrangular shape. Some specimens are much compressed, others somewhat convex, and these variations are equally observable in our Indian specimens as in the typical ones from Aachen, of which I had very good examples for comparison, obtained from Dr. Bosquet.

Localities.—East of Anapaudy, north of Serdamungalum, and near Olapaudy, mostly in a brownish sandstone; not rare.

Formation.—Trichinopoly group. In Europe the species appears to occur all through the upper cretaceous (Plæner) beds of Germany.

✓ 2. ERIPHYLA FORBESIANA, Stoliczka, Pl. VI, Figs. 14-16.

1846. *Artemis lenticularis*, Forbes, Trans., Geol. Soc., vii, p. 147, pl. xviii, fig. 7.

Eriph. testa fere regulariter orbiculari, valde compressa, umbonibus paululum tumescentibus, approximatis et incurvis; lunula profunda, anguste ovata; area fere nulla, fulcris in fissura profunda sitis; superficie costulis acutis, tenuibus, nonnunquam paululum undulatis, interdum lamelliformibus, interspatiis latioribus

intus subtilissime striatis separatis tecta. Cardo dentibus sicut in specie typica instructus.

Length of largest specimen	...	...	...	...	25 m. m.
Height : length	...	...	...	...	0.98 - 1.05
Thickness : height	...	...	...	...	0.30 - 0.32

This is an almost perfectly orbicular species, very flat and compressed, slightly tumescent at the umbones, which are pointed and strongly incurved, touching each other. The lunula is elongately ovate and very deep; a separate area can hardly be said to exist, the fulcrum supporting the ligament lying in a very narrow fissure with perpendicular sides. The ornamentation is peculiar, the whole surface being covered with sharp concentric sometimes almost laminar thin ribs separated by broader interspaces, which are again very minutely striated. The width of the sulci slightly varies, and they are less conspicuous when the ribs are somewhat undulating.

Forbes had figured this species under the name of *Art. lenticularis*, but in his description he mostly had in view specimens which actually were identical with the European species; his reference to the recent *Art. lincta*, Pult., also clearly indicates this.

Locality.—Ninnyoor, in a white earthy limestone; rare.

Formation.—Arriallor group.

✓ 3. ERIPHYLA DIVERSA, *Stoliczka*, Pl. VI, Fig. 6.

Eriph. testa quadrangulariter rotundata, crassiuscula, concentrice numerosissime et anguste lirata, convexiuscula; umbonibus valde prominulis, acutis, paulo incurvis; declivitate lunulare ad marginem profunde excavata, areale fere rectiuscula; lunula et area profundis, prima ovali, altera elongata, postice angustissima.

Height : length	...	...	...	...	0.96
Thickness : height	...	...	...	...	0.44

This form greatly resembles in shape the more convex varieties of *Eriph. lenticularis*, but the beaks are more prominent and pointed, and the surface is covered with rather strong very close ribs; one or two deeper sulci being only slightly indicated; the ornamentation is, however, characteristically different from that of the above-named species.

Locality.—South-east of Vylapaudy; only a single specimen was found in a greyish somewhat conglomeratic rock.

Formation.—Arriallor group.

XV. *Family*,—*GLOSSIDÆ*.*

All the animals referable to this family have an oval or elongately oval shape, being stout and thick; the mantle has a very large opening ventrally in front for the protrusion of the foot, and another large gape behind for the siphons, the margins being united only for a short distance between both openings. The siphons are separated, short, and with fringed orifices; the foot is somewhat compressed, more or less conical and pointed at the end, a byssal groove occurs sometimes on the lower side, but the byssus itself is very rarely developed; the gills are large, unequal or sub-equal, the palpi long and narrow, the retractile muscles very strong.

The shells are sometimes elongated, but mostly of an oval inflated form, solid; the hinge provided with two or three cardinal and one posterior lateral tooth, some slight modification occurring in both; the pallial line is entire or very slightly sinuated (in *Coralliophaga*), and the ligament is external.

H. and A. Adams have divided the shells which here form the family *GLOSSIDÆ* into three families. The question, however, as to the relation of *Cyprina*, *Trapezium* (= *Cypricardia*), and *Glossus* (= *Bucardia* or *Isocardia*) has been lately so fully discussed by Deshayes in his 2nd edition of the Paris fossils that I can be brief on this subject. Deshayes includes those three generic groups with *Cardium* in one family, but comparing carefully the shells and animals with those of true *Cardia*, there is, I think, sufficient reason to treat them separately in distinct families. The animals of the *GLOSSIDÆ* certainly greatly resemble those of the *CYRENIDÆ*, but those of the *CARDIIDÆ* show in the form of the foot the crenulations of the mantle margins, and in the arrangement of the hinge-teeth considerable differences, as I had already mentioned when speaking generally of the order *VENERACEA*, and as I shall again point out when I come to speak about the *CARDIIDÆ*; I think the distinctions warrant the separation of the two families.

On the other hand, I entirely agree with Deshayes as to his classification of the genus *Trapezium* (= *Cypricardia*), which H. and A. Adams place in the *TAPESINÆ*. There can, I believe, be no doubt that a very gradual transition in the form and arrangement of the hinge-teeth can be traced from one genus into the other, and the same applies to the form of the shell itself. Thus, for instance, we have in *Callocardia* apparently the *Veneroid* type without any posterior lateral teeth. *Glossocardia* has the form of *Trapezium*, but the arrangement of the hinge-teeth is similar to that of *Glossus*. The various forms of the fossil genus *Veniella* again exhibit a gradual transition from the hinge of the *Glossus*-type to that of *Cyprina*, so much so that in some instances, as those referring to *Veniella* proper and also to *Venilicardia*, great difficulty is experienced in drawing a line between the two. Further details on this point will be seen from a comparison of the characteristics of the various genera. Besides various fossil species of which

* The name *CYPRINIDÆ* may be more appropriate and would have priority, but it has already long ago been used in Ichthyology.

the hinge has already been made known, I shall add here a few others which in external form, at least, closely resemble some species of *Trapezium* and others.

Taking all the recent species together there are not more than about 25 of them known, including two or three new species from our eastern seas. *Cyprina* is a northern form, *Glossus* and its allies may be called inhabitants of the temperate and sub-tropical zones, while *Trapezium* and the forms closely allied to it are mostly tropical species. The geographical range of the family is in so far extensive, but the geographical distribution of the single species is not great.

The study of this family is more important for the palæontologist. Various forms with a thin shell and more or less rudimentary hinge-teeth already occur in some of the oldest sedimentary deposits; they mostly are of the *Trapezium** type. The thicker forms with better developed hinge-teeth are met with in the Trias, increasing in variety in the jurassic deposits; in the lower cretaceous period forms resembling *Glossus*, and especially *Cyprina*, are still very numerous, but in the uppermost cretaceous beds the number somewhat decreases, though the same types of shell still occur. In the older tertiaries the fauna has already more resemblance to the present one, the number of species again somewhat decreasing; and in the newer tertiary deposits the generic forms, at least, are almost without exception identical with the present ones; the number of generic and specific types being here the smallest.

1. *Modiolarca*, Gray, 1840. Shell trapezoidal, moderately inflated, thin; beaks almost contiguous, incurved; anterior portion of the shell more compressed, narrower and shorter than the posterior, which is obtusely carinated; surface covered with a smooth shining epidermis; hinge with one or two small, sometimes almost obsolete teeth in each valve; muscular impressions small, pallial line entire.

H. and A. Adams (Gen., II, p. 519), propose a special family to receive this genus, placing it, apparently following Gray, next to the *MYTILIDÆ*; the authors quote two recent species of which the type was described by Lamarck as *Modiola trapezina*. Deshayes in his second edition of the Paris fossils (I, p. 532 and p. 541) criticizes Gray's classification, and attempts to prove that there is not sufficient reason for separating generically the shells in question from *Trapezium* (*Cypricardia*). Deshayes also describes two eocene species, one with two hinge-teeth, and one with a single hinge-tooth in each valve. I was first inclined to class these peculiar shells next to *Mysia* (*Diplodonta*) and the fossil *Psathura*, but looking at the animal and shells of *Modiolarca*, the first being characterized by partially united mantle lobes, two short cirrated siphons, four gills united behind, and the other by the peculiar trapezoid form, incurved sub-anterior beaks, small roundish muscular impressions, I am inclined to follow Deshayes in his statement, that we have in *Modiolarca* a modification of the *Trapezium* type of shells. At the same time I cannot see how it would be possible to characterize the genus *Trapezium*, if this should be regarded generically the same as *Modiolarca* and *Coralliophaga*; they must all be kept distinct, and, as I said, when the fossil shells have been more

* Sandberger says that true *Trapezia* occur even in the Devonian.

carefully examined, many more genera may be added to this sub-family, showing it to be one of the most important in fossil Conchology.

2. *Apricardia*, Guéranger, 1867, (Album paléont. du Dépt. d. l. Sarthe, &c., expli., p. 13, pl. 16, fig. 21). Shell elongated, inequilateral, like a *Trapezium*, solid; hinge with one strong, recurved tooth in each valve, the tooth being in the left valve almost directly under the beak and in the right a little posterior to it; to each tooth corresponds an equally large cavity in the other valve.

This peculiar form resembling *Trapezium* is distinguished by the simple form of its hinge; it is based upon a cretaceous species, *Apr. carinata*.

3. *Anisodonta*, Desh., 1860, (Paris foss., 2nd edit., i, p. 542). Shell ovately elongated, compressed, inequilateral; hinge with one sharp tooth in each valve and a pit beside it, fulcra distinct, short, thick. Such is the distinctive characteristic given by Deshayes of a small fossil shell, *A. complanatum*, from the Paris basin ("sables marins inférieurs de Châlons-sur-Vesle"). It is not perfectly plain what is meant by the pit next to each tooth. The figure shows in the right valve a large broadly triangular and in the middle apparently excavated tooth just below the beak, and in the left there is one stronger anterior compressed tooth and one smaller posterior in front of the fulcrum; probably this is more correct than the description; the muscular impressions are elongated and pallial line entire. The general form of the shell is that of typical *Trapezia*.

Faujas-Saint-Fond published in 1808 (Annales du Museum, Paris, xi, p. 384, &c.) a short account of a fossil shell from the tertiary deposits of Italy, naming it *Clotho* (non *idem*, Walckenaer, 1807, *Arachnoidea*). This shell resembles in form *Anisodonta*, except that it is a little less inequilateral and apparently of very solid structure, but the hinge-teeth are remarkably similar to those noticed in the last genus. The author says that there is one bifid tooth in each valve, somewhat compressed and recurved towards the beaks, one tooth being much larger than the other; two muscular impressions and an interior ligament. The accompanying figure shows one large triangular bifid tooth in the right valve and one compressed, descending long tooth posterior to it; in the left valve there is one large anterior and one small posterior tooth, and an additional short compressed descending tooth behind the beak. The difficulty is how to explain in Faujas-Saint-Fond's figures the posterior descending teeth; if these are equivalent to what Deshayes considers to be the fulcra in *Anisodonta*, in which they are, however, ascending, we have a perfect analogy between the two shells in question, and they may still be referable to the same genus. I do not think this to be at all improbable, for the arrangement of the hinge-teeth in both, *Anisodonta* and the form called *Clotho*, are in principle very much the same as those of *Trapezium*, with a species of which *Clotho* has apparently been found. However, if the posterior descending teeth of *Clotho* are to be looked upon as cartilage processes, the shell must be referred to the *CORBULINÆ* close to *Sphenia*. In spite of F.-S.-Fond's statement, that the ligament is internal, I do not think the latter case more probable than the former; neither can it be decided by a reference to

the pallial impression, of which no notice is taken in the characteristics given. In the figure of the right valve it would seem as if a deep pallial sinus were indicated, in the left valve everything is quite confused.

Chenu (Man., ii, p. 97,) copies Faujas' original characteristic, or rather Philippi's (Handb., p. 319), who says that the ligament is external; the same author quotes a species *Clotho Faujasii*, but the hinge of the right valve figured by Chenu appears to show considerable difference from that of the original species of *Clotho*; the form of the two shells also does not agree. I do not know where to find an explanation for this discrepancy; possibly the former may be a different species, or is it only one of the many wrongly copied figures of fossil shells in Chenu's Manual?

4. *Coralliophaga*, Blain., 1824. Shell elongated, sometimes sub-cylindrical, of a more or less thin structure; hinge with two compressed cardinal and one lamellar posterior lateral tooth, all teeth being more or less parallel to the superior margin of the valves; pallial sinus generally with a small broad sinus.

5. *Trapezium*, M. v. Mühlf., 1811. Shell trapezoid, solid, usually with a characteristic radiating striation on the surface; hinge with three more or less regularly diverging cardinal teeth, the anterior in the right and the posterior tooth in the left valve being the smallest, the middle one in the right valve the largest, and the posterior one usually bifid; posterior lateral tooth lamellar and parallel to the superior margin; pallial line entire, truncated posteriorly. The two anterior cardinal teeth in the left valve are sometimes united by a low ridge, forming so to say one elongated curved tooth, which is, however, more curved than in *Veniella*, but considerably less than in *Venilicardia*.

6. *Isoculia*, M^cCoy, (?) 1844. Under the name of *I. ventricosa*, M^cCoy figures (Carb. limestone fossils of Ireland, pl. 13, fig. 3), a very tumid, cordate shell with a few concentric distant constrictions, indicating stages of growth. The shell appears perfect and closed; I have not been able to find any further reference to this shell in this or any other work. Possibly it may be an *Edmondia*, or a *Cardiomorpha*, for on pl. 8, fig. 15, of the same work is also a species noted as *Isoculia corrugata*, but in the text (page 56) referred to as a *Cardiomorpha*.

7. *Callocardia*, A. Ad., 1864, (Ann. Mag. Nat. Hist., xiii, p. 307). Shell cordate and inflated like in *Glossus*, posteriorly scarcely flexuous, thin and without epidermis; hinge of the left valve with two unequal cardinal teeth; the anterior angularly bent on itself in the middle with a triangular pit on either side and with four prominent cusps at the margin; the posterior oblique, curved, narrow, but elongated, and with two indistinct marginal cusps; no lateral teeth are present; pallial line simple and muscular impressions semi-lunar.

There is as yet only one (left) valve of this remarkable species, *C. guttata*, known from the Chinese seas. The absence of the posterior lateral tooth, as well as the peculiar cuspidation of the two hinge-teeth, distinguish it readily from *Glossus* or *Veniella* (= *Venilia*, Morton, subg. *Anisocardia*), but the form of the angularly bent "anterior" cardinal tooth undoubtedly strongly recalls *Glossocardia*,

while the cuspidation recalls the equivalent tooth of *Meiocardia*. It may also be worthy of notice that the posterior lateral tooth of the left is in all the allied forms of *Glossus* always much smaller and more marginal than that of the right valve.

8. *Meiocardia*, H. and A. Adams, 1856. Shell trapezoid, inflated, with the beaks distant, strongly in-and re-curved, a ligamental groove extending from each of them posteriorly in a flexuous line; hinge with the teeth thin, lamellar, and arranged in a line parallel to the superior margin of the shell; right valve with one angularly bent anterior cardinal tooth, its posterior arm being ascending and very prominent; posterior cardinal tooth very long, obliquely and obsoletely cross-grooved; left valve again with an anterior angular cardinal tooth, its hinder portion being higher and longer than the front part which is bituberculated; posterior cardinal tooth double, being furrowed in its entire length for the reception of the single tooth of the other valve; posterior lateral teeth distinct, single in the left, double in the right valve.

The type of this, which I think to be a good genus, is *Meiocardia Moltkiana*, Spengler. The general character of the shell, its thin structure, and the arrangement of the hinge-teeth are quite distinct from those of *Glossus*, in which the posterior cardinal teeth partially overlap the anterior, which become inferior, while such is not at all the case in *Meiocardia*, in which also the posterior cardinal of the left valve is very different from the corresponding tooth of *Glossus*. Römer in his recent Monograph (Mart. and Chem. Conchyl.-kabinet, 1869, vol. x, pt. iii, p. 8, &c.) only acknowledges two recent species, *M. Moltkiana* and *vulgaris*, considering *M. tetragona*, *Lamarckii*, and *Cumingii* merely as varieties of the two. Although the form of *Meiocardia* is very commonly to be met with among fossil shells, I am not acquainted with a single species which, according to its hinge, could be referred to it. It is also impossible to hit upon the authority from whom Chenu (Man., ii, p. 114), derived his two cretaceous *Meiocardia*; the one refers to *Isoc. pyrenaica*, d'Orb., but where d'Orbigny figured an *Isoc. Guerangeri* I have not been able to ascertain. The hinge-teeth of the recent *Meiocardia* are extremely tender and fragile, and the greatest care would be required to expose them properly in fossil forms.

9. *Cardiodonta*,* Stol., 1867, (Laube in Denksch. Acad., Wien, vol. xxvii, pt. ii, p. 39). Shell cordiform, inflated, with prominent incurved beaks; hinge with two cardinal and one thin or lamellar posterior lateral tooth in each valve; ligamental groove long, narrow, marginal; right valve with a strong, grooved posterior and one oblique simple anterior cardinal tooth, the latter running from the beak more or less parallel to the lunular margin; left valve with a single posterior and a thick anterior cardinal tooth strongly prominent above.

* The MSS. on the Gastropoda and mostly also on the Pelecypoda of the Balin beds were prepared by me in 1861 before my departure to India, and it was I who urged a revision of the work, when in 1865 and 1866 my friend, the late lamented Dr. M. Hörnes, asked me to consent to the publication of my MSS. This fact should have been stated, for in records, published elsewhere, it would appear as if that revision had been done without my having seen the necessity for it.

Only the type species *Card. Balinensis* is sufficiently well known, it is a jurassic form; but it seems, as Mr. Laube remarks, very probable that some more species will be shown to belong to this genus; he already quotes *Isoc. minima* of Sowerby and *Isoc. gibbosa* of Münster. The cretaceous formation will very likely have also its contributions, but I have not come across a single form from tertiary beds.

10. *Glossus*, Poli, 1791, (*Bucardia* et *Isocardia* auctorum). Shell ventricose, concentrically striated and covered with an epidermis, beaks distant, strongly incurved and bent outwards, a ligamental groove extending from them posteriorly; hinge with two cardinal and one posterior lateral tooth in each valve, all arranged parallel to the hinge margin; right valve with the supero-posterior cardinal tooth long and imperfectly divided by an oblique furrow, the anterior portion being separated from the single antero-inferior cardinal tooth by a deep longitudinal pit; left valve with the postero-superior cardinal tooth long, lamelliform, simple, and with the antero-inferior cardinal more prominent, both being separated from each other by a long groove, the latter also is divided by an oblique furrow into two parts, the anterior portion possessing below a small pit for the lower tooth of the right valve. The only known recent species is the well known *Glossus* (*Isocardia*) *cor*, Linné; it also occurs in the European and North American upper and middle tertiary beds, at least the various forms described under different names have lately all been identified with the recent species. In spite of the very numerous fossil species described as *Isocardia* (= *Glossus*), I do not know a single one which would exhibit an arrangement of the hinge-teeth identical with the type species; and until this has been shown we cannot speak of fossil species of *Glossus*. The cretaceous *I. similis* of Sowerby seems to be the nearest approaching to the type.

Having thus to deal with a single species of the genus, its nomenclature is easily settled. Our shell was known to Scilla and Lister, who called it *Bucardia*, but I do not think it can be said with the classificatory spirit of Linné, though probably with the intention that this designation should distinguish the shell in question from others. Klein in his "Tent. meth.," 1753, p. 140, classed our shell in his genus *Isocardia*, what he calls the second species—*lævis*, which he divides into *Bucardia* and *Camadia*: the former he again divides into six groups, and as the second of the series he quotes Lister's shell. It is clear that this arrangement can have no claim upon our system of nomenclature, though *mutatis mutandis* it is correct that Linné's *Chama cor* was included in what Klein called a genus *Isocardia*. In 1791 Poli described our shell as *Glossus rubicundus* and the animal as *Glossoderma*. The former is the first distinctly generic name together with a specific one; the latter must be replaced by 'cor' of Linné, but the former evidently has full authority. If we apply the strictest scrutiny to these facts we cannot justly dispense with Poli's name *Glossus*. For, though Lamarck introduced Klein's name *Isocardia* already in 1799, he quotes Linné's species only in 1819 as *Isoc. cor*, after it had been in 1811 called by Meg. v. Mühlfeld *Bucardium*, and in 1817 by Schuhmacher *Bucardia communis*, Klein's

name *Isocardia* must be regarded as synonymous with Gray's *Acanthocardia*, *Card. echinatum* being figured by the former as one of the type species; the other two of Klein's figures will scarcely admit of any reliable identification. For what reason Römer (Mart. and Chem. Conch.-kab., vol. x, pt. iii, p. 5,) increased the number of synonyms by proposing in 1869 for *Glossus cor* the name *Tycho-cardia* it is really difficult to understand.

11. *Glossocardia*, Stol., 1870. Shell elongately trapezoid, sub-ventricose, concentrically striated, beaks tumescent, obtuse, close together as in *Trapezium*; ligamental furrow narrow and long, as in *Glossus*; hinge with two cardinal and one posterior lateral tooth in each valve; the supero-posterior cardinal teeth generally are more or less distinctly bifid, at least the one in the right valve, which has anteriorly a thin, sub-obsolete prolongation bent downward; it is separated from the inferior cardinal and bluntly tubercular tooth by a deep sickle-shaped groove in which fits the similarly shaped antero-inferior cardinal tooth of the left valve; this tooth is provided on the upper side with two grooves, their distance being equal to the width of the pit into which the antero-inferior tooth of the right valve fits. I consider as the type of this genus *Cypricardia obesa*, Reeve, (vide his Monograph of *Cypricardia* in Conch. Icon., vol. i). My friend, Dr. J. B. Baxter, has collected a few valves of this rare species at Barkley Island near Port Louis (Mauritius), the locality of the species having been previously unknown. In general character this shell closely resembles a *Trapezium*, being elongated and having the beaks close to each other, but it has not the characteristic radiating striæ of that genus, and the hinge shows most marked differences. The two cardinal teeth and the somewhat remote posterior lateral tooth readily indicate a greater relation to *Glossus* than to *Trapezium*; and the anteriorly produced and downward bent portion of the upper cardinal tooth of the right valve places it near *Veniella* (= *Venilia*, Mort.), while the sickle-shaped form of the antero-inferior tooth of the left valve distinguishes it readily from that genus.

Another typical species of *Glossocardia* is the tertiary *Isocardia subtransversa*, d'Orb., (see Hörnes' Moll. d. Wiener Beckens, vol. ii, p. 166, pl. 20, fig. 3); it differs from the recent species by a distinctly margined lunula, and by being less high posteriorly than anteriorly. A third species appears to be Zittel's *Isocardia planidorsata*, (Bivalven der Gosau-gebilde, Denksch. Akad., Wien, vol. xxiv, pt. ii, 1865, p. 140, pl. 5, fig. 4), though it also exhibits great relation to *Veniella* proper. *Cyp. crassidentata* of the same author is also doubtful. There will no doubt in time be several other fossil species shown as belonging to *Glossocardia*, when their hinge-teeth have been carefully studied and compared with the typical forms.

12. *Veniella*, Stol., 1870, (*Venilia*, Morton, 1834, Synop. org. rem. of the cret. group of U. States, p. 67, not *id.* Dupouch., 1829, Alder and Hanck., 1844, et alii). Shell ventricose, inflated, with the beaks outwardly incurved, more or less distant, a long narrow ligamental furrow running from them posteriorly, situated above strong fulcra; hinge with two cardinal and one posterior lateral tooth in

each valve; right valve with the supra-posterior cardinal tooth, generally bifid anteriorly with a hook-like downward bent prolongation, infero-anterior cardinal smaller, lamelliform, or more or less tubercular, separated from the other tooth by a more or less horizontally extending flexuous groove into which the infero-anterior cardinal tooth of the left valve fits, the supero-posterior cardinal of this valve is moderately prolonged, single or indistinctly bifid.

There appear to be three somewhat different forms belonging to this genus.

Morton (loc. cit.) says of *Veniella*, "hinge with three robust cardinal teeth in each valve." In the type species, *V. Conradi*, which he figures, the anterior bent portion of the supero-posterior cardinal tooth of the right valve appears to be rather strongly thickened at the end, and the other cardinal tooth below it has a distinct projection to meet that thickening. The consequence is, that the groove separating the two teeth and the corresponding tooth of the left valve are more or less distinctly divided into two pits or teeth. This is exactly what is to be already observed in the jurassic *Isocardia cordata*, Buckmann (see Denksch. Akad., Wien, vol. xxvii, pt. ii, p. 41, pl. 4, fig. 1), and the form of the shell as well as of the hinge of *Isocardia cyprinoides*, Braun, (in Sandberger Conch. d. Mainzer-Beckens, p. 315, pl. 25, fig. 2,) also appears to correspond well with Morton's type.

12a. In some other species, for which Munier-Chalmas (Jour. de Conch., 3^{me} ser., vol. iii, 1863, p. 288,) proposed the name *Anisocardia*,* the hooked end of the supero-posterior tooth of the right valve is very little, and the antero-inferior cardinal of the same valve scarcely thickened on the inner or upper side, except very slightly at its base; consequently the groove separating the two teeth is more continuous, and the corresponding tooth of the left valve is flexuous, being constricted only in the middle. The type species which M. Chalmas describes is *Anisocardia elegans* from the Kimmeridge clay at Havre.

Several cretaceous species which I shall mention subsequently also belong to this group which, as it mostly includes small forms with rather thin shells, may be retained under the sub-generic name *Anisocardia*. Deshayes' *Cypric. acutangula* and *isocardioides*, (Paris foss., 2nd edit., pl. 57), evidently also belong to this sub-genus.

12b. *Venilicardia*, Stol., 1870. This is suggested to include a third group of the *Veniella* type, such as the cretaceous *Cyprina bifida*, and possibly also *C. crassidentata* of Zittel, and our *Ven. Arcotica*, n. sp., or the tertiary *Cyprina tumida* of Nyst (Belg. foss.), and very likely also the jurassic *Cypricardia cordiformis* of Deshayes, and several others. All these species are characterized by a strong, thick shell, of large size, the supero-posterior cardinal teeth are as usually more or less bifid, the one in the right valve with a very easy curve at the anterior end, the antero-inferior cardinal teeth of both valves are long, flexuous, and their posterior ends are in both cases strongly thickened and tubercular. This distinction from

* Dollfuss (Faune Kimm., 1863, pp. 23 and 71, pl. 10, figs. 9-14,) quotes the same as *Apocardia*, a name which Munier first suggested, but afterwards altered without having given publicity to it.

typical *Veniella* appears rather constant in all the species from various formations, but it seems hardly sufficient to base a generic character upon; I shall, therefore, retain it as a sub-genus only.

Thus comparing the characters of the various forms of *Veniella* with those of *Glossus*, or *Meiocardia* and *Cardiodonta*, the differences are readily seen; all the shells, no doubt, belong to the same type, but the arrangement and form of the cardinal teeth present remarkable and constant distinctions. I will particularly mention *Glossocardia*, because its upper cardinal teeth are almost identical with those of *Veniella*, but while the antero-inferior tooth of the left valve of the last genus is horizontally prolonged and flexuous, the same tooth is in *Glossocardia* recurved downwards towards itself, resembling that of the recent *Callocardia*; and again the corresponding tooth of the right valve is in *Veniella* always elongated and attenuated in front, while in *Glossocardia* it is tubercular, separated anteriorly from the margin by a deep groove.

Veniella forms, as regards shape, a transition from *Trapezium* and *Glossus* to *Cyprina*; the only difference being that in the latter there is a separate tooth present in place of the sickle-shaped end of the supero-posterior tooth of the right valve of *Veniella*.

Conrad (Am. Journ Conch., vol. ii, 1866, p. 103,) says of *Veniella*, "a genus unknown in the tertiary." From what I have already stated, it is unnecessary to say that Mr. Conrad's statements in confining certain genera to certain formations have no foundation whatever. *Veniella*, as restricted, and the sub-genus *Anisocardia*, (and probably also *Venilicardia*), certainly occur in strata from the jurassics up to the upper tertiaries and have their analogue among recent shells in *Meiocardia*, *Callocardia*, and *Glossocardia*.

13. *Goniosoma*, Con., 1869, (Am. Jour. Conch., v, p. 43). Shell sub-quadrangular, moderately tumid, angular along the region from the beak to the infero-posterior end; muscular impressions marginal, pallial line—? hinge in the right valve with two prominent cardinal teeth and a long anterior lateral, parallel with the hinge margin; type *G. inflata*, Con., from cretaceous rocks of New Jersey. The external form of this shell resembles *Veniella*, but the hinge appears to be very different.

14. *Cyprina*, Lam., 1812. Shell more or less inflated, cordate, with the valves uniformly convex, or along the posterior margin carinated, ligament external placed in a longitudinal groove and supported by more or less thickened fulcra; each valve with three cardinal and one posterior lateral tooth; in the right there is a strong, generally bifid posterior cardinal tooth, and two anterior cardinals placed somewhat obliquely one above the other and connected by a low ridge; both these teeth are highest posteriorly and attenuate anteriorly, and a slight ridge which continues in the latter direction bounds above and below an obliquely extending groove; in the left valve we have a long and thin posterior cardinal tooth and two anterior, placed almost side by side; the first (or middle) one is pyramidal and laterally compressed, being stretched in a more or less vertical direction; the

† *Goniosoma*, Con. is very different from *Veniella* in its shape, and in the arrangement of its teeth. It is more inflated, and its hinge is different, and its teeth are differently arranged.

most anterior is sub-trigonal, attenuating towards the front; a low ridge runs from the top of this anterior to the base of the middle cardinal, dividing obliquely the great gape between them in two pits into which the superimposed anterior cardinal teeth of the right valve fit.

This explanation of the relative position of the hinge-teeth readily shows the great similarity existing between the present genus and *Veniella* as already indicated.

Only one recent species, *Cyp. islandica*, is known; typical forms occur in the tertiary and cretaceous beds; but whether any of the jurassic and older *Cyprinae* really belong to this genus has yet to be satisfactorily ascertained.

14a. *Cicatrea*, Stol., 1870. I propose this name provisionally only as a sub-division of *Cyprina*, taking our cretaceous species *Cyp. [Cic.] cordialis* as the type. The form of the shell is distinguished by its remarkably sharp and high ridge running from the umbones to the postero-inferior end of the shell; the beaks are distant and strongly incurved, and from each runs posteriorly a rather short but deeply bifurcate groove in which the ligament is lodged. This very much recalls some species of *Spisula*, for there are no special fulcra; the hinge margin below the beaks is entire. The posterior cardinal teeth are rather narrow in both valves (while in *Cyprina* proper the one in the right valve is very thick and bifurcate); the two anterior cardinals in the left valve are very large, the same superimposed teeth in the right valve, however, very small; the anterior muscular impression is anteriorly margined by a sharp ridge. The form of the shell strongly recalls *Hemicardium*.

The principal peculiarity of this perhaps new generic form is the presence of a deep bifid ligament groove and the relative proportions of the cardinal teeth; it remains to be shown by further discoveries whether these characters are connected with the remarkable cordate and elongated form of the shell, and whether they are in other forms constant. A species that likely belongs to it is d'Orbigny's cretaceous *Isocardia pyrenaica*.

15. *Cyprinopsis*, Conrad, 1869, (Am. Journ. Conch., v, p. 101,) is characterized as "equivalve, two anterior cardinal teeth and one very oblique tooth in the right valve, pallial line entire;" type *Artemis elliptica*, Smith. Journ. Geological Society, vii, p. 15, figs. 2-3. I do not know the species unless it is believed to be identical with *Meretrix ovalis*, Gabb, (Pal. Calif., i,) which does not seem to exhibit any particular distinctions from *Cytherea*.

CRETACEOUS SPECIES BELONGING TO THE *GLOSSIDÆ*.

Pictet and Campiche in their Pal. Suisse (4^{me} ser., 3^{me} pt., p. 211, &c.) note the species referable to this family under the generic names of *Cyprina*, *Cypricardia*, *Venilia*, and *Isocardia*. I am only sorry to say that it is almost impossible to comment upon most of the species described, their hinges being known comparatively only in very few instances; however the review will show us how much remains to be done for the study of the family.

As it appears of little consequence in which order the species are here enumerated, I shall follow the arrangement of Pictet and Campiche, in order to facilitate comparison, adding in each case the species which were described under the abovementioned generic names.

1-10.—*Cyprina Bernensis*, Leym.; *C. Marcousana*, Lor.; *C. Deshayesiana*, Lor.; *C. Carteroni*, d'Orb.; *C. Valangiensis*, *Aubersonensis*, *fusiformis*, and *Orbensis* of Pict. and Camp.; *C. Abbaticæ*, d'Arch.; *C. securiformis*, Sharpe;—except the last named species, which is to all appearance a true *Cyprina*, the others are only known from more or less imperfect casts which do not admit of a correct generic determination.

11.—*C. Saussuri*, P. and Renev., is probably a *Cyprina*.

12.—*C. angulata*, Sow. Pictet and Campiche (loc. cit., p. 221, &c.) devote a good deal of attention to this interesting species which, they say, they had compared with specimens from Nièvre and Sonne, &c.; they identify it with Leymerié's and d'Orbigny's *Eryensis*. I am sorry that I have no good specimens from either of the localities to compare, but there is certainly a discrepancy in the figures, which is worth noticing; for unless it had been explained, it is almost impossible to arrive at the proper generic determination of the shell, though the specific one may be quite correct. Sowerby's original figure (Min. Conch., pl. 65,) shows in the left valve three cardinal, one lunular (or perhaps anterior lateral) and one posterior lateral tooth; the author's description does not give an explanation of this, and it is almost certain that there must be some kind of mistake in the figure, for it does not correspond with any known genus of the *VENERACEA*. D'Orbigny's figure of a part of the hinge of the right valve is also not sufficient to clear up the matter; there we have only two divergent cardinal teeth; the lower anterior must be wanting if the figure be intended to represent a *Cyprina*.

13.—*C. rostrata*, Sow. The original figure of the left valve evidently represents a form of *Veniella*, namely, the sub-genus *Venilicardia*.

14-15.—*C. inornata*, d'Orb., and *C. Rhodani*, P. and Roux.

16.—*C. cordiformis*, d'Orb. The figure of the hinge of the left valve is not quite complete, but it clearly seems to indicate a species of *Veniella*, perhaps belonging to the sub-genus *Anisocardia*.

17.—*C. regularis*, d'Orb.; the figure of the hinge of the left valve seems imperfect, unless it represents a species of *Cardiodonta*, and even with this the position of the hinge-teeth does not quite agree.

18.—*C. quadrata*, d'Orb. Judging from d'Orbigny's figure it may be a form of *Veniella*, but with enormously strong cardinal, and very small posterior lateral teeth.

Geinitz (Quadersandstgeb., p. 156,) identifies with it his *Isocardia cretacea*, a view which is not supported by the description and figure given of the last named species. The same author also quotes *Trigonia parvula* of Reuss, being probably identical with *C. quadrata*; this seems still less probable; but, of course, it is very difficult to judge from figures of very imperfect specimens. We have several specimens of Geinitz' *I. cretacea* in our collection, but they are perfectly insufficient to clear up the doubtful points.

19.—*C. crassicornis*, Ag., sp. Judging from the inflated form and apparently thin texture of the shell I think this species probably an *Anisocardia*.

20.—*C. cuneata*, Sow. This is a typical *Anisocardia* (*Veniella*). Sowerby gives the figure of the left valve, and I have examined the perfect hinge of the right valve in our own collection.

21.—*C. Fergusoni*, Salt. Reference is made to the presence of a lateral tooth, but the cardinals are not pointed out.

22.—*C. globosa*, Sharpe. Gabb (Proc. Am. Phil. Soc., &c., June 1861, vol. viii, p. 175,) substitutes for this name *C. Sharpeana*, the name *C. globosa* having been already formerly applied by d'Orbigny to Römer's jurassic *Cardium globosum*, which is identified with Goldfuss' *Venus tenuistria*. It is difficult to say which name will stand. In Römer's figure of a cast the number of the ribs is evidently exaggerated, it amounts to about half a dozen. Goldfuss' figure of a left valve, if correct, represents an *Anisocardia*; thus Sharpe's name may after all not require to be changed, but unfortunately the figure and description which he gives of his species do not allow of a generic determination.

- 23.—*C. oblonga*, d'Orb., is a *Venilicardia*.
- 24.—*C. Ligeriensis*, d'Orb., apparently belongs to the same sub-genus, which determination appears to be supported by the specimen figured by Geinitz (Kieslingsw., &c., pl. ii, fig. 13), under the name of *Cyp. rostrata*.
- 25-26.—*C. Neptuni*, d'Orb.; *C. Archiaciana*, d'Orb. (*Crassatella quadrata*, d'Arch.); of neither of the species are the hinges known.
- 27.—? *C. incerta*, d'Arch. This is a remarkable species, having much of the form and character of a *Tancredia*, but it could also be a *Veniella*.
- 28-29.—*C. Noueliana* and *C. intermedia*, d'Orb., are perhaps *Venilicardiæ*, as the figures of the casts only show two cardinal teeth.
- 30.—*C. consobrina*, d'Orb., is an *Anisocardia*.
- 31-37.—*C. Coniacensis*, Coq., *C. elongata* and *Royana*, d'Orb., *C. Geneti* and *Edgardi*, Coq., *C. Bosquetiana* and *Provencialis*, d'Orb., are all as yet very imperfectly known.
- 38.—*C. cordata*, Sharpe, has much more the type of a *Caryatis* than of any genus belonging to the *GLOSSIDÆ*.
- 39.—*C. orbicularis*, Röm., is very likely an *Anisocardia*.
- 40-42.—*C. bifida*, *C. crassidentata*, and *cycladiformis* of Zittel all belong to *Veniella*; the first and probably also the second belong to the sub-genus *Venilicardia*, and the third is perhaps an *Anisocardia*.
- 43.—*C. crassitesta*, Rss., uncertain.
- 44-45.—*Cypricardia isocardia* and *subcarinata* of d'Orbigny are almost only known by their names.
- 46.—*C. testacea*, Zittel, is either a *Veniella* or a *Venilicardia*; the anterior teeth are not sufficiently clearly drawn to decide on this point.
- 47-49.—*C. tricarinata* and *trapezoidalis*, Röm., sp., and *C. protracta*, Rss., are only known from imperfect casts; they all have the general form of *Trapezium* and of the externally allied genera *Glossocardia* and *Veniella*, &c.
- 50.—*Cyp. Valdensis*, Lorient, (Mat. Pal. Suisse, 4^{me} ser., 1868, p. 24,) has the external form of a *Glossocardia*.
- 51.—*Apricardia carinata*, Guér., vide p. 185.
- 52-56.—*Isocardia neocomiensis*, (*Ceromya* apud Agassiz, ? = *I. gaultina*, P. and C.), *I. Valangiensis*, P. and C., *I. praelonga*, Leym., *I. Montmollini*, P. and C., and *I. angulata*, Phil.: of none of these are the hinge-teeth known, the shells have the general form of *Anisocardia*, but some of them are so thin that they could moreover indicate species of *Ceromya*.
- 57.—*I. similis*, Sow.; this is almost the only species which in general character very much approaches the recent *Glossus cor*, but the tooth of the right valve figured seems to me, though imperfect, to indicate by its position rather a *Veniella* or *Anisocardia* than a *Glossus*.
- 58-62.—*I. cryptoceras*, *obliqua*, *semiradiata*, *Carentonensis*, and *Renauxiana* of d'Orbigny are all imperfectly known.
- 63.—*I. pyrenaica*, d'Orb., may, as already mentioned, belong to the sub-genus *Cicatrea* of *Cyprina*.
- 64-69.—*I. longirostris*, Röm., (= *I. ataxensis*, d'Orb., and *Cyp. Boissyi*, d'Arch., and ? = *I. trigona*, Röm.), *I. cretacea*, Goldf., *I. turgida*, Rss., *I. lunulata*, Röm., *I. pygmæa*, Rss., *I. modiolus*, Nils., are only known from imperfect casts.
- 70.—*I. galiciana*, Alth., has the form of a *Cicatrea*, but the hinge is not known, (vide Favre, Descript. d. Moll. foss. de Lemberg, 1869, p. 111).
- 71.—*I. sub-quadrata*, Alth., rather appears to be a cast of a *Cardium* than of any species of *GLOSSIDÆ*, (vide Favre, l. cit., p. 111).

72.—*I. Heberti*, Favre, l. cit., p. 112, has quite the external form of a *Glossus*, but the hinge is unknown.

73.—*I. planidorsata*, Zitt., is either a *Glossocardia* or a *Venilicardia*.

74-84.—Coquand (Monog. Étage Aptien de l'Espagne, 1865, p. 109, &c.) describes the following:—*Cyprina expansa*, *C. æquilateralis*, *C. curvirostris*, *C. carinata*, *C. inornata*, *C. Saussuri*, and *C. modesta*; *Isocardia pusilla* and *Iso. nasuta*; *Cypricardia secans* and *C. nucleus*; of none of these species are the hinge-teeth known, and the generic determination is, therefore, quite problematic.

85.—*Isocardia crenatula*, Con., is mentioned by Fraas from Palæstine, (Würt. Jahresh., xxiii, 1867, p. 238).

86.—*Cyprina pinguis*, Guéranger, (Album paléon. Dépt. de la Sarthe, 1867, pl. 17, figs. 2-3); uncertain.

87-88.—*Isocardia massagetica*, Eichw., and *I. ventricosa*, Pusch, are noticed by Eichwald (Leth. Ross., livr. xi, 1867, p. 704, &c.) as occurring in cretaceous rocks of Russia; they only externally agree with *Glossus*.

89-96.—*Cyp. eximia*, Eichw., *C. Cancriniana*, d'Orb., *C. transversa*, Eichw., *C. cincta*, Eichw., ? *C. Syssolæ*, Keys., *C. Khoroschovensis* and *C. lævis*, Rouil., *C. Helmerseniana*, d'Orb., are also recorded by Eichwald from cretaceous deposits, (ibid. p. 661, &c., &c.); of not a single species, however, have the hinge-teeth been examined.

97-99.—*Cyp. Mülleri*, (= *Cyp. rostrata*, Sow., apud Müller), *C. van-Reyi*, (= *Cyp. Ligeriensis* d'Orb., apud Müller), and *Cypricardia rugata* are mentioned as new by Dr. Bosquet from the cretaceous deposits at Aachen (see Foss. fauna en flora van Het Krijt v. Limburg, extract from Staring's Bodem v. Nederland, pt. ii, numb. 377, 378, and 380).

100-109.—*Cyprina Nicaisei*, *trapezoidalis* and *africana*; *Cypricardia Thersites*; *Isocardia aquilina*, *Jubæ*, *numida*, *neglecta*, *getulina* and *Moevusi* are described as new species by Coquand from the Province Constantine; looking at them from a conchological point of view they are scarcely worth recording.

110-112.—*Cypricardia Galiciana*, Favre, (= *Crassatella tricarinata*, Kner.) and *C. parallela*, (*Crassatella idem*, Alth.) are described by Favre in his descript. d. Moll. foss. de Lemberg, 1869, p. 109; both have the form of *Trapezium*.

From America the following are recorded by Meek in his Check-list of cretaceous shells of the United States (1864, Smith. Misc. Coll., No. 177).

113-125.—*Glossus Moreauensis*, *Washita* and *Conradi* of Gabb; *Cyprina compressa* and *ovata* of Meek and Hayden; *Venilia Conradi*, Mort., *V. humilis*, M. and H., *V. Gabbana*, M., *V. Mortoni*, M. and H., *V. subtumida*, M., *V. rhomboidea* and *trapezoidea*, Conr., *V. trigona*, Gabb, *V. Laphami*, Shum. sp.

126.—Conrad in his Check-list of eocene fossils (Smiths. Misc. Coll., No. 200,) quotes *Cyprina bisecta* from the lower eocene beds which Gabb and other geologists pronounce to be cretaceous.

127.—*Trapezium carinatum*, Gabb, Pal. Calif., i, p. 170.

128.—*Cypricardia texana*, Römer, (Kreidegeb. von Texas, p. 50); hinge not known; the shell has the appearance of an *Arca*.

129.—*Goniosoma inflata*, Conrad, vide p. 191.

Schafhäutl (Süd. Bayerns Leth. Geogn., 1863, pp. 265 and 268,) has an *Isocardia ovum* and a *Cyprina acuminata*, but whether those insufficient casts to which these names have been applied are cretaceous or not the author does not say.

130-132.—In the South Indian cretaceous deposits five species of *GLOSSIDÆ* occur; none of them were noticed by Prof. Forbes, for the only species which he describes as *Isocardia subsinuata*

is a *Ceromya* (see p. 78). However, of the five species which I have to mention only four are sufficiently well preserved to admit of a reliable determination, *Veniella* (*Venilicardia*) *obtruncata*, *Cyprina Forbesiana* and *cristata*, and *Cyprina* (*Cicatrea*) *cordialis*; one species apparently belonging to *Trapezium* is only known from a single imperfect valve; until better specimens have been discovered it would be useless to burden our literature with names which cannot have any value either for the geologist or palæontologist, but would only remain a puzzle to the conchologist.

Thus, looking at the family *GLOSSIDÆ*, as represented in cretaceous rocks, we find a great number of well defined species belonging to *Veniella*, one or two may be *Glossocardia* and a few belong to *Cyprina* proper, and its sub-genus *Cicatrea*. Of *Glossus* itself not one species is known with certainty, but that form of shell does occur. Few species also externally resemble *Trapezium*, but none is sufficiently certainly known by its hinge. *Apricardia* is as yet entirely cretaceous and so is *Cicatrea*, but both are likely to occur in other formations also, the first most probably in the tertiaries, the last in the upper jurassics.

TRAPEZIUM, *Meg. v. Mühlf.*, 1811, (vide p. 186).

✓ ? TRAPEZIUM, sp. ind., Pl. XIII, Fig. 4.

A trapezoid, or almost quadrangular left valve, moderately inflated, with a prominent sub-obtuse beak; the region between it and the postero-inferior end is the highest, and from it the shell slopes very gradually on either side, the supero-posterior and antero-inferior extremities being mostly extended; the surface is covered with minute radiating striae and a few distant concentric grooves, indicating stages of growth. Hinge-teeth unknown.

The remarkably quadrangular form of this species and the moderate thickness of its shell make it probable that the species belongs to *Trapezium*, but it was impossible to trace the hinge-teeth in the only figured right valve known.

Locality.—North of Serdamungalum, in a yellowish highly calcareous conglomeratic sandstone.

Formation.—Trichinopoly group.

VENIELLA, *Stol.*, 1870, (vide p. 189).

✓ VENIELLA [*VENILICARDIA*] *OBTRUNCATA*, *Stoliczka*, Pl. VIII, Figs. 4-7.

Ven. testa sub-quadrangulari, valde inflata, crassa; umbonibus incurvis, approximatis, obtusiusculis; lunula moderate excavata, sub-rotundata, latiuscula, linea impressa marginata, area longa angusta, sub-profunda, et nymphis crassissimis instructa; valvis in regione ab umbonibus ad terminationem postero-inferiorem extensa maxime elevatis, ab ea elevatione antice versus gradatim et convexiuscule-, postice rapide-declivi; superficie striis concentricis tenuibus ac nonnullis crassioribus notata; cardo in valva dextra dente longo postico indistincte bifido, curvato, oblique descendente ac altero antico horizontaliter extenso, inæqualiter diviso, postice maxime elevato, in valva

sinistra dente postico tenui, breviori, antico elongato, sub-flexuoso, et in utraque valva dente laterali postico moderato instructus.

Height	:	length of shell ...	...	...	varying from 0.85 - 0.92
Thickness	:	" "	...	...	" " 0.90 - 1.00
Length of largest specimen	:	...	...	...	80 m. m.

This species has its nearest ally in Zittel's *Cyprina* [*Venilicardia*] *crassidentata* from the Gosau formation, but our shell is always shorter and more tumid than the European species, in which also the posterior cardinal tooth of the right valve is more distinctly bifid. The thickness of the shell varies considerably, (as shown on plate viii); an obtuse indistinct ridge runs from the beaks to the postero-inferior end; the lunula is roundish or broadly oval, surrounded by an impressed line; the beaks are strongly incurved, rather close together, only in old very inflated specimens distinctly curved outward with their points. The surface of the shell exhibits striæ of growth, some of which are, especially nearer to the periphery, stronger and more closely placed than in the centre. The valves close perfectly without leaving any posterior gape. The fulcra and the hinge-teeth are remarkably robust.

Localities.—Koloture, Serdamungalum, Alundanapooram, Comarapolliam, Arrialoore, Vylapaudy, Olapaudy, &c., &c.

Formations.—Trichinopoly (the three first named localities) and Arrialoore groups; rather rare in the former, but common in the latter.

CYPRINA, Lam., 1812, (vide p. 191).

✓ 1. CYPRINA FORBESIANA, Stoliczka, Pl. IX, Figs. 2-8.

Cyp. testa ovato-elongata, plus minusve tumida, carina acuta ab umbonibus ad terminationem infero-posteriorem decurrente instructa, in superficie distanter crasse lamellose costata ac striata, antice ad peripheriam rotundata, infra paululum flexuosa, subrecta, supra ac postice fere uniforme convexiuscula; umbonibus valde prominentibus, incurvis, approximatis; nymphis crassis; area angustata, longa, ad medium elevata; lunula transversaliter ovato-elongata, infra profundiuscula et linea impressa marginata; cardo dentibus tribus cardinalibus et uno postico laterali in utraque valva iis Cyprinarum typicarum persimilibus instructus.

Height	:	length of shell...	...	...	varying from 0.73 - 0.86
Thickness	:	" "	...	...	" " 0.55 - 0.83
Length of largest specimen	:	...	...	...	75 m. m.

Shell elongately ovate, more or less tumid, according to which the proportions of height to the length vary; beaks strongly incurved, close together, a rather sharp ridge running from them to the infero-posterior end, which is somewhat attenuated, being less high than the front part; the surface is covered with more or less distant, lamellar, concentric ribs, between which some thinner striæ are to be

observed; these ribs are especially prominent on the anterior portion of the shell in front of the umbonal ridge, but behind it on the areal portion only the smaller close set striæ prevail.

The area itself is large, long, margined by a low ridge (see figs. 4 *a* and 6 *c*), and prominent along the median line, that is, where the edges of the two valves meet. The lunule is broadly oval, somewhat deep, and below margined by an impressed line, more or less interrupted by the striæ of growth. The nymphæ are very strong and prominent.

The hinge is perfectly similar to that of *Cyprina islandica*. In the right valve there is one but slightly furrowed posterior cardinal, and two anterior cardinals one above the other connected by reciprocally issuing projections, and each of them is anteriorly somewhat prolonged. The left valve has also three cardinal teeth, the posterior is the thinnest and elongated, the middle is slightly prolonged, and the anterior is sub-triangular with a small inferior pit; the upper end of the anterior tooth is connected with the base of the middle one by an oblique low ridge. The posterior lateral teeth are in both valves strong and elongated; the muscular impressions deep.

The form and ornamentation readily distinguished this species from others. The perfect identity of the hinge-teeth with those of the recent *Cyp. islandica* is a very interesting fact.

Localities.—Alundanapooram, Serdamungalum, east of Anapaudy, Koloture, &c., in ferruginous or greyish highly calcareous sandstone; common.

Formation.—Trichinopoly group, for which the present species seems to be a characteristic fossil.

2. CYPRINA CRISTATA, *Stoliczka*, Pl. IX, Fig. 1.

Cyp. testa sub-quadrangulari, alta, carina acutissima ab umbonibus ad terminationem infero-posteriorem decurrente instructa, sub umbonibus emarginata et infra emarginationem paulo producta ac rotundata; superficie antice lamellis crassis distantibus concentricè curvatis ornata, ad utrumque latus carinæ lævigata; lunula parva, transversaliter ovulata, non excavata, infra linea duplici marginata.

Height	:	length of shell	...	...	...	...	0.87
Thickness	:	"	"	...	...	...	0.50

The only specimen known is the one represented in Plate ix. I have not been able to obtain a view of the hinge-teeth, but from the external great similarity with *C. Forbesiana* I presume that it is also a *Cyprina*. However, it is possible that it belongs to the sub-genus *Cicatrea*, for on close examination I found that the fulcra are not prominent, as noted in fig. 1 *c*, but I cannot see a double groove for the ligament; thus the generic determination requires confirmation. It is readily distinguished from the former species by being less inflated, much higher in proportion to its length, with the umbonal carina much stronger and sharper,

and with thick lamellar ridges ornamented only in front, while on either side of the carina the surface is smooth. The lunula is below margined by a double impressed line; the area is rather flattened; the nymphæ not prominent.

Locality.—Arrialoore, in a light grey sandstone.

Formation.—Arrialoore group.

CICATREA, *Stoliczka*, (vide p. 192).

✓ 3. CYPRINA [CICATREA] CORDIALIS, *Stoliczka*, Pl. X, Figs 1, 2

Cyp. [Cicat.] testa elongata, valde inflata, umbonibus valde prominentibus et incurvis instructa, postice attenuata, carina acutissima ab umbonibus ad terminationem postero-inferiorem decurrente, in superficie costulis lævigatis crassiusculis concentricis ornata; regione supero-postica eminenter cordiformi, moderate convexa; lunula cordata, linea impressa marginata; ligamentum in duabus furcis paululum divergentibus, lamina crassa testacea separatis et postice breviter prolongatis, situm.

Height	:	length of shell	...	...	...	...	0.62
Thickness	:	"	...	...	...	...	0.71
Length of largest specimen			...	...	...		80 m. m.

This beautiful species is distinguished by a very high and sharp ridge running from the beaks to the postero-inferior end, giving the shell when viewed perpendicularly towards the supero-posterior (fig. 1b), or towards the antero-inferior region, an eminently heart-shaped outline. The surface is marked with concentric distant ribs, which are especially distant near the beaks, these being strongly prominent, incurved, and somewhat distant from each other. The ligament is, as already stated, lodged in a double groove; the lunula is cordate, obtusely pointed below and margined by an impressed line. The left valve has three cardinal teeth, the posterior one being very thin, laminar, the two anterior are triangular and very strong, the base of the median being united with the top of the anterior by a low rib; a distinct rib is seen in front of the anterior muscular impression, it has the appearance of an anterior lateral tooth, but has in reality nothing to do with the hinge-teeth. Of the right valve I observed distinctly only the two anterior cardinal teeth being almost confluent into one. On a cast specimen the muscular impressions are very much elevated; they must be, therefore, deeply excavated on the shell, which is remarkably thick.

I have already alluded to d'Orbigny's *Isocardia pyrenaica* and *I. galiciana*, Alth., which are the only cretaceous species bearing some resemblance to this interesting fossil.

Localities.—Serdamungalum and Koloture, in a light coloured sandstone; rare.

Formation.—Trichinopoly group.

XVI. *Family*,—*CYRENIDÆ*.

The animals possess a thick fleshy mantle, especially along the edges, which are entire; the margins are open almost all round, except for a very short distance below the siphons; these are two, distinctly developed, usually slightly united at the base and merely with the orifices separated and fringed; sometimes, as in *Sphærium*, the siphons are prolonged and distinctly separated towards their terminations; in a few species of Indian *Corbiculæ* the siphons are also somewhat produced, but only at the orifices separated, exactly as in *Cyprina islandica*, the retractile muscles are very strong and of a semicircular shape. The foot is generally moderately produced, laterally compressed, broad and attenuated towards its end, below near the base provided with a byssal groove; the palpi are two on either side, rather narrow and lingui-form, finely striated; the gills are in pairs, one on each side, sub-equal, coarsely striated and large, occupying from $\frac{1}{2}$ to $\frac{2}{3}$ of the total length of the body.

The shells are sub-cordate, usually moderately inflated, strong and solid in the brackish-water-, thinner in the fresh-water-species, always covered with an olivaceous, brittle epidermis, the shell-surface itself being concentrically striated or sulcated; hinge with two or three cardinal teeth in each valve and one lateral tooth on either side, single in the left, double in the right valve; ligament external; pallial impression very often with a small but not quite distinct posterior sinus, sometimes simple.

The species referred to the present family may be looked upon as the brackish and fresh-water representatives of the entire order *VENERACEA*. Their animals very closely resemble those of *Cyprina* and other *GLOSSIDÆ*, as exhibited by the brief account given by Fischer of the anatomy of a *Cyrena* (Journ. de Conch., 1863, p. 5). The anatomy of our *Cyrena Bengalensis* agrees with Fischer's account in general, but I hope to give a fuller account of it at some future date. I have also examined several species of Indian *Corbiculæ*, and as far as the form of the foot and of the siphons is concerned, they are almost identical with *Cyprina*. On the other hand, the shortness of the siphons, the almost entirely separated mantle-margins, and the great size of the gills leaves no doubt that we have in the *CYRENIDÆ* a group of animals which form the passage from the *GLOSSIDÆ* to the *CARDIIDÆ*.

All the recent species are characterized by a covering of a peculiar brittle epidermis. In the brackish forms, such as *Cyrena* and *Batissa*, the beaks are commonly found much eroded; this is chiefly due to the influence of the ebb and tide, the specimens remaining during low water very often for eight and nine hours dry, or buried in soft mud. Such is also the case with old *Corbiculæ* when they live in tanks or streams where the water often dries out, but in young shells the beaks are generally found perfect, because the shells mostly live between water plants, and permanently in water.

Temple Prime, who favoured this family with his special study, says (Monog. Am. *CORBICULADÆ*, Smith. Misc. Coll., No. 145, 1865, pp. 3, 12, &c.) that the

American *Corbiculæ*, *Cyrenæ*, and others possess a pallial sinus, while the species from other countries have the pallial impression simple. The same author suggests that further anatomical examinations, upon which he is at present engaged, may lead to the discovery of characters which could form the basis of generic distinction. As far as the pallial sinus is concerned, I cannot but doubt this, although I have had no opportunity of examining the animals of any of the American species. *Cyrena Ceylanica*, *Sumatrana*, and *Bengalensis* all possess a more or less distinct pallial sinus, though I readily admit that it is not so well developed and so deep as in *C. Carolinensis* or *Salmacida*, but there can be no mistake as to its existence in either of the cases. All the Indian and Java species of *Corbicula* (about twelve) which I have examined equally show the posterior end of the pallial impression either truncated or distinctly and usually broadly insinuated. I state this merely because I have from my own materials not been able to detect any generic distinction between the American and the Eastern *Corbiculæ* and *Cyrenæ*, but by no means with an object to anticipate, or differ from, any conclusions to which Mr. Prime's large materials may lead. His results will no doubt be more weighty than those derived from the comparison of a few species.

In addition to the well known six recent genera of the *CYRENIDÆ*, I will quote here only two fossil ones, *Diodus*, Gabb, based upon a cretaceous species from California, and *Isodoma*, Desh., based upon an eocene shell from the Paris basin. The former represents the group of genera with three cardinal teeth in each valve, and the latter the one with only two cardinal teeth.

1. *Cyrena*, Lam., 1806. Shell sub-cordiform, robust, moderately inflated, hinge with three sub-parallel, more or less bifid cardinal teeth, one strong, smooth, or very minutely and partially transversally striated* lateral tooth on either side; pallial sinus short, more or less distinctly indicated, sometimes nearly obsolete.

2. *Diodus*, Gabb, 1868, (Pal. Calif., ii, p. 242; *Cyprinella*, Gabb, olim). Shell equivalve, sub-cordiform; hinge with three diverging, (simple ?) cardinal teeth and one anterior and one posterior lateral smooth tooth in each valve; pallial sinus shallow.

This is proposed for a doubtfully cretaceous species, *D. tenuis*, Gabb, from California. It is difficult to distinguish this suggested new genus from *Cyrena*, except that the three cardinal teeth of the right valve are in Gabb's figure thinner and more distinctly diverging from one point than is usually the case in recent species of *Cyrena*. Should this position of the hinge-teeth prove to be of any value as compared with the last named genus, Zittel's *Cyr. solitaria* may also be referred to *Diodus*, but I hardly think that we can look upon this division in a more than sub-generic sense, perhaps scarcely in that.

3. *Velorita*, Gray, 1834. Shell cordate, inflated, posteriorly somewhat attenuated and produced, robust, lateral teeth very finely striated, somewhat elongated, the anterior lateral is very close to and almost touching the most

* In *Cyrena Bengalensis* for instance.

anterior of the three cardinal teeth, it is nearly horizontal; pallial sinus short, but distinct.

4. *Batissa*, Gray, 1852. Shell broadly cordate, moderately compressed; cardinal teeth bifid, lateral teeth elongated, on the outer side only, or sometimes on both sides; cross grooved; pallial impression usually truncate posteriorly. The shells of *Batissa* generally are somewhat compressed; they may be regarded as an intermediate form between *Cyrena* and *Corbicula*, agreeing with the former in the usual larger size and the habitat in brackish waters, with the latter in the elongated form of the lateral teeth, although the anterior lateral tooth is perceptibly shorter than the posterior one, while in *Corbicula* both are very nearly equal in length and much compressed.

5. *Corbicula*, Meg., 1811. Shell cordate, moderately inflated, with three more or less distinctly bifid, cardinal teeth, and one much elongated, compressed, and transversally finely striated lateral tooth on either side; pallial line posteriorly truncated, or with a short sinus.

The anterior cardinal tooth of the right and the posterior cardinal of the left valve are in some species very small, and especially the latter sometimes almost obsolete. This makes it difficult in generically separating the Wealden forms, although they almost invariably seem to possess only two cardinal teeth in each valve.

6. *Isodoma*, Desh., 1860, (Paris foss., 2nd edit., i, p. 481). Shell thin, fragile, resembling a *Clementia*, elongately ovate, moderately tumid; hinge of right valve with two bifid diverging cardinal teeth, and one distinct remote lateral tooth on either side; pallial sinus not known.

This is based upon a fossil species, *I. cyrenoides*, from the Paris basin; in general character the shell recalls *Clementia* and some other allied forms with a thin shell, which have been provisionally referred to the *DOSINIINÆ*, but the dentition of the hinge of *Isodoma* has its only analogue among the *CYRENIDÆ*.

7. *Pisidium*, Pfeiff., 1821. Shell ovate, moderately inflated, beaks tumid; hinge with two diverging more or less distinctly bifid cardinal teeth, and one lateral tooth on either side in each valve; pallial impression entire, truncate posteriorly; ligament placed always on the shorter side of the valves. Siphons of the animal united to the end, short. There are usually two cardinal teeth in each valve, the posterior in the right and the anterior in the left are mostly bifid, the two others single; in very aged specimens the cardinals occasionally become nearly obsolete.

8. *Sphaerium*, Scop., 1777, (*Cyclas*, Brug.). Shell ovate, generally somewhat elongated, moderately inflated, beaks tumid, but slightly prominent; hinge usually with two, short, closely approached cardinal, and two prominent lateral, teeth, one on each side; pallial impression entire; ligament placed always on the longer side of the valves. Animal with the siphons elongated and separate.

Setting aside the distinction existing between the animals of the two last genera, there appears to be a remarkable difference in the position of the cardinal teeth. In *Pisidium* the cardinal teeth are elongated, diverging, and when the

valves close the teeth are placed parallel or nearly so beside each other; in *Sphærium*, however, the cardinal teeth are tubercular, or of a columnar shape, placed obliquely towards each other, and when the valves close the axes in which they are placed partially cross each other, though the position is not so distinctly developed as in the *CARDIIDÆ*, but the passage from the present to the next family is distinctly indicated by this arrangement. Sometimes the anterior cardinal tooth of the left valve is in *Sphærium* obsolete, at other times it is replaced by a very low indistinctly bituberculated ridge.

In a geological point of view the *CYRENIDÆ* are not very important, for it is not often that we meet with fossil species belonging to them, a fact due to the rarity of fresh-water deposits. Nothing positive is known of their occurrence in carboniferous rocks, though there are various species described which in form greatly resemble some *Velorita* and *Cyrenæ*. From the middle jurassic also a few species have been recorded by Forbes and others, but their determination is unsatisfactory, though they to all appearance belong to the present family. The Wealden, which may be considered rather as the close of the jurassic than the beginning of the cretaceous period, contains a tolerably large fauna of *CYRENIDÆ*. Most of the species described by Sowerby (Trans. Geol. Soc. and Min. Conch.), Römer and Dunker (Norddeutsch. Wealdenb., &c.), and others under the generic name *Cyrena* appear to belong to the *Corbicula* type, having the lateral teeth much elongated, and thus indicating a true fresh-water fauna. The species require a critical examination, for if Dunker's statement,—that they all possess only two cardinal teeth in each valve—is unexceptionally correct they must form a separate genus, distinct from *Corbicula*, because they do not agree, on account of the length of the lateral teeth, with either *Pisidium* or *Sphærium*; these two last genera also seem to be represented already in the Wealden deposits, though the generic determination can by no means be regarded as satisfactory. With regard to the Wealden so-called *Cyrenæ*, it is to be remembered that in all the recent *Corbiculæ* the most anterior cardinal tooth of the right valve and the posterior of the left one are very small and occasionally nearly obsolete, those teeth being only indicated by a very slight swelling of the termination of the lateral teeth. It seems probable that at least in some of the Wealden species, as *Cyrena Heysii*, Dkr., *C. elliptica*, Dkr., *C. ovalis*, Dkr., and others, such is really the case, for the position of the remaining cardinal teeth almost indicates it; we would, therefore, have in those species the first known representatives of *Corbicula*. Unless, however, this point has been satisfactorily settled, it would be premature to suggest any new generic changes. Species like *Cyrena caudata*, and a few others, would seem to indicate also the occurrence of *Velorita* in Wealden rocks.

From the cretaceous deposits we have only a few species upon record as *Diodus tenuis*, Gabb. (antea p. 201), *Cyrena solitaria*, Zittel, (Denksch. Acad., Wien, xxiv, pt. ii, p. 133), and *Cy. cretacea*, Drescher, (Zeitsch. Deutsch. Geol. Gesellsch., xv, p. 345). The first two may belong to one and the same genus, or

sub-genus, as stated already, for the lateral teeth of *C. solitaria* are not so long and more prominent than they are in typical *Corbulæ*, to which genus Zittel suggests that his species may be referable. *Cy. cretacea* in form more resembles *Velorita* than a *Corbicula* or *Cyrena*; the author mentions the occurrence of two small cardinal teeth and on either side one elongated lateral. Besides that the same author (l. cit.) quotes a *Cyrena? sp. indet.* from the Quader-sandstone near Sirgwitz, (? Zirgwitz), in form resembling the former species, but possessing three cardinal teeth.

Zittel also describes from the Gosau deposits (l. cit., p. 134, &c.) a *Cyclas gregaria* and *C. ambigua*; both are apparently species of *Sphærium*, but the hinge-teeth have not as yet been satisfactorily examined.

In addition to the above species quoted from cretaceous deposits I may mention *Cyrena arenaria*, Meek and Hayden (Meek, Check-list of cret. Am. fossils, p. 13.—*Cyprina* id., Proc. Acad. Nat. Sc., Phil., for 1857, p. 143).

No species of *CYRENIDÆ*, in fact no true brackish- or fresh-water Pelecypoda, have as yet been found in the cretaceous deposits of Southern India.

In the eocene beds we meet with true species of *Cyrena*, as seen in Deshayes' Description of Paris fossils and in Sowerby's Min. Conch., &c., &c. Both forms, with the pallial impression distinctly insinuated and entire, occur, and besides also forms which recall by their smaller thickness *Batissa*, and others, possessing an elongated form, like *Velorita*; true *Corbiculæ* are rare. During the miocene deposits the change of the climate appears to have greatly affected the development of this family. *Cyrena*, *Batissa*, and allied forms have greatly diminished and partially disappeared from the European continent, while *Corbicula*, *Sphærium*, and *Pisidium* increased in number, they being all fresh-water species and apparently more adapted to a colder climate. In the Indian upper tertiary deposits several *Cyrenæ* occur, and so also in the American. At the present time the brackish-water forms are almost entirely restricted to the tropical and sub-tropical regions of the whole world, and the fresh-water forms are more numerous in the former than they are in temperate regions.

The total number of species belonging to the family as at present known must be nearly 300; of this more than one-half comes under *Cyrena* and allied forms, which clearly shows that Dunker's statement (Wealdenbild., p. 29,) as to the number of fossil species being greater than that of the recent ones is exaggerated.

XVII. Family,—CARDIIDÆ.

The animals of the typical *Cardia* are characterized by two separated, but very short siphons with fringed orifices, and a long more or less cylindrical and generally geniculate foot. The mantle is very widely open in front and below, united only in one point just below the siphons. The gills are in one pair on each side, of moderate size, unequal, the outer thick plume being smaller than the inner, which

is grown together posteriorly with the corresponding plume of the other side; the palpi are four, close together, and slender.

I shall keep the forms of the above type under the name of *CARDIINÆ*. Their shells are equivalve, more or less cordate and usually inflated, sometimes moderately elongated, rather robust, and ornamented, partially or wholly, with radiating tuberculated or spiny ribs, which in rare instances are reduced to mere striæ. There are two muscular impressions; the inner margin of the shell is partially or wholly crenulated or toothed; the ligament is external, the pallial impression generally entire, truncated sometimes but rarely, with a short sinus. The hinge is composed of two cardinal teeth in each valve which cross each other when the valves close; there is one anterior and one posterior lateral tooth present, rarely becoming obsolete.

The position of the cardinal teeth is one of the most characteristic features in the shells of this family, and readily distinguishes even those which, like *Lævicardium* and others, in external form resemble species of the *CYRENIDÆ*. Even where one or the other of the cardinal teeth become obsolete the remaining retain their crossing position.

The brackish- and fresh- water *Cardia* of Eastern Europe appear, however, to make an exception to this to a certain extent at least; these I shall class as a special sub-family under the name of *LYMNOCARDIINÆ*. The animals of these,—judging from the few species found living,—exhibit very marked differences from those of the marine *Cardia*. The siphons in *Didacna*, Eichw., which is the principal genus of the sub-family, are elongated and united nearly up to the end, and the foot is laterally compressed and broad at the base; thus the external character of the animal is that of the *MYIDÆ*, specially recalling *Lutraria* or *Pholadomya*. With the latter the form of the shell also agrees, except in the one point, that it has no cartilage; but it seems by no means without reason that our shells have been by several naturalists previously classed with *Pholadomya* in the same genus. Römer lately (Martini and Chem. Syst. Conch.-kabinet, vol. x, 1869, p. 12,) inclines to Gray's suggestion that these forms are nearly allied to *Panopæa* and *Cyrtodaria*. There can be little doubt that, if we look upon the shell of *Didacna*, with its animal, independently of all other allied forms of *Cardia*, its systematic place can hardly be better than that indicated by Gray. However, when we come from the series of marine tertiary beds of Eastern Europe containing such elongated forms of *CARDIINÆ*, as *Acanthocardium latum* and *Cerastoderma edule*, gradually to a series of brackish-water and then to almost purely fresh-water deposits, which contain forms of *CARDIINÆ* very similar to the last ones, but of thinner structure, a posterior gape, sometimes with a pallial sinus, and some of them possessing cardinal and lateral teeth, perfectly characteristic of the above named sub-family, the question arises whether we are entitled to separate the latter as a thoroughly distinct group of shells, or not. Any one who has seen these deposits (the Sarmatic group) and studied its fauna will, I firmly believe, say that such a thing is impossible. There are some peculiarities which these fresh-water *Cardia* have of

their own, as noted above, and these induce me to propose for them the name *Lymnocardium*. Detailed characteristics will be given further on. The reasons which make it most probable that the *Lymnocardia* have to be associated with the recent *Didacna* of Eichwald must for the present be taken from geological evidence. In looking over the fauna of the Sarmatic deposits* of the Crimea (see Mém. Soc. Geol., France, 1^{me} ser., vol. iii, 1868, p. 1, &c.), we find that there are a number of Crimean *Lymnocardia* specifically the same as those occurring in similar beds in Southern Hungary. With these there are, however, other species associated which do not possess lateral teeth, but either two or one, or no cardinal teeth, and thus are in every way identical with Eichwald's *Di-* or *Mono-* or *A-dacna*.

These data, I think, sufficiently justify the classification of the *LYMNOCARDIINÆ* with the other *CARDIINÆ* in one family; and it yet remains to be shown by the examination of more species and their comparison with marine *Cardia* whether the distinction of the animals of *Didacna* are really so important and constant as to overthrow all the above arguments regarding the classification of these shells. We know from the account given of other families that changes similar to those pointed out in the animals of *CARDIINÆ* and *LYMNOCARDIINÆ* are by no means rare. In the *SOLENIIDÆ*, for instance, we have *Pharella* with united siphons and *Novaculina* with perfectly separated siphons, while all the other characters of animal and shell are in both almost identical. In the *MYIDÆ* we have *Mya* and *Anatina* with long united (*Poromya*, *Thracia*), and others with more or less shortened and partially divided, siphons. Speaking of larger groups we can refer to the *LUTRARIINÆ* on one and the *MACTRINÆ* on the other hand; and again the *VENERINÆ* and the *DOSINIINÆ*, the latter having long united siphons, perfectly like those of the *LYMNOCARDIINÆ*. And again the fresh-water genera *Sphærium* and *Pisidium* have the siphons more or less united and elongated, while the brackish *Cyrenæ* of the same family have them very short and separated.

These (and many other instances which could be cited) distinctly show that the observation of *Didacna* having a united siphon, is by no means an isolated example, but that similar changes of development are most common among many other families of Pelecypoda. When we consider that the animals only of a few species of *Didacna* have as yet been examined, and, on the other hand, those of by no means all the species of *CARDIINÆ*, particularly of the elongated *Papyrideæ*, (with pallial sinus), we can hardly be justified in stating that no intermediate forms between the last named sub-family and the *LYMNOCARDIINÆ* exist. The shells unquestionably indicate them, and there is every reason to believe that such will also be found to be the case with the animals.

* Some of which appear to be of more recent date than the true "Congerien Schichten" of the Vienna and Hungarian basin.

a. *Sub-family*,—*CARDIINÆ*.

In the arrangement of genera and sub-genera I shall principally follow H. and A. Adams.

1. *Cardium*, Linn., 1758. This name has been reserved for a small group of strongly costated species which Römer (Mart. and Chem., l. cit., 1868, p. 13,) proposed to call *Tropidocardium*.

Shell rather thin, inflated, and nearly equilateral, with a sub-rectilinear hinge area; surface ornamented with distant radiating spiny ribs; two small cardinal teeth in each valve, one or the other of the upper teeth sometimes become obsolete; lateral teeth lamelliform, posterior gape generally distinct, rarely narrow. The type of this genus for which Linné's name has been restricted is *Cardium costatum*, L., and species belonging to it seem first to appear in the eocene rocks. The form is tolerably common during the miocene time, while only two species are found living, (*costatum* and *hians*). Some fossil species like *Burdigalinum* distinctly indicate a transition to the next group.

1a. *Acanthocardium*,* Gray, 1853. Shell tumid, rather solid, slightly inequilateral, with closely set, more or less, spiny or tuberculated radiating ribs; cardinal teeth small, lateral strong, posterior gape very narrow, or not at all developed. The type of this section is *C. aculeatum*. Species belonging to it are already found during the jurassic period and gradually increase in number up to the present date. Species like *C. Nuttallii* are again truly intermediate between this and the next section, and should perhaps rather be referred to the latter, as pointed out by H. and A. Adams.

1b. *Pectunculus*, Adams., 1757, includes the species of the type of *C. asiaticum*. There is no distinction in the form of this and the previous sub-genus, only that in the latter the ribs are usually more numerous and less spiny than in the former.

1c. *Trachycardium*, Mörch, 1852 (?). This sub-generic group is distinguished by a thick, solid, and high shell ornamented with numerous radiating rough ribs; the hinge area is strongly curved and very short, the laterals being close to the cardinals, and both strongly developed: in the right valve the two cardinals are often grown together into one broad obliquely compressed tooth deeply grooved on either side.

The first fossil species of this type appear to be as yet known only from cretaceous rocks, and even in the subsequent formations they are scarce. Römer, however, refers seventeen recent ones to it, *C. elongatum*, Brug., being probably one of the best known to conchologists.

Gabb (in Pal. Calif., ii, p. 266,) proposes to call a number of cretaceous species, of which *C. productum*, Sow., is the best known, *Granocardium*; the species forming the sub-genus are said to be characterised by the intermediate ribs

* *Idem*, Römer, 1868, l. cit., p. 17. I do not think that a change in the inflection of a word can in this case be considered as an alteration of the word itself. The original word being *Cardium*, it should in the compound words remain and not be changed to *-cardia*, because it then excludes the free use of the plural of *-cardium*, and in any case is liable to cause confusion.

being granulate. Such can be seen on both ends of the shell of *C. orbita* for instance, which is a *Trachycardium*; I don't see, therefore, the necessity for a new sub-genus.

1d. *Cerastoderma*, Mörch (ex-Poli,) 1851. Shell broadly ovate or longitudinally cordate, inflated, inequilateral, posterior side somewhat longer and nearly closed at the end; surface ornamented with numerous closely set thick ribs; cardinal teeth small, the upper ones sometimes imperfectly developed; laterals distinct. Type *C. edule*, L. Species of the same type seem first to be met with in the European cretaceous rocks; they are rare in the European eocene, but more common in those of Asia; of recent species Römer quotes only three, identifying with *C. edule* several forms which formerly were considered as distinct.

2. *Papyridea*, Swainson, 1840. Shell elongately ovate, posterior side sensibly longer than the anterior, more or less gaping; of a rather thin structure; hinge line long, straight, or slightly curved; surface radiately ribbed, ribs more or less granulated or spinose, pallial impression mostly sinuated; upper cardinal tooth of left valve sometimes obsolete, or nearly so, (*Card. bullatum*, Linn.). This type is hardly represented in cretaceous rocks, a few species are known from the tertiaries, and of recent ones only four are referred to it by Römer,—*Card. bullatum*, *rugatum*, *ringiculum*, and *papyraceum*, (loc. cit., p. 74, &c.), but it is not evident why such apparently distinct forms as *C. bullatum* and *Cumingii* should be referable to one and the same species. The thin structure of the shell which is posteriorly produced and the usual presence of a pallial sinus distinguish this genus from *Cardium*.

I have again to mention Meek's *Liopistha* (see p. 71 and Smith. Misc. Coll., No. 177, 1864, pp. 12 and 32). Meek says,—“the shells embraced in this group which seems to be peculiar to the cretaceous system have, according to Mr. Conrad, the hinge of *Papyridea*, Swains. They differ, however, from the type of that genus (*C. bullatum*, Linn.) in being closed and without costæ on the postero-dorsal region, or crenulations in the posterior margins of the valves. They are also much thinner shells.” Römer's *Card. elegantulum* from Texas is considered as the type of this so-called new genus, and Meek in his list (loc. cit.) adds three others. It is absolutely necessary to know upon which species Mr. Conrad made the observation regarding the similarity of the hinge with *Papyridea*, or his observation must be at least confirmed by the examination of some closely allied species. I can at the present only say that the well known *Pholadomya caudata*, Römer, or *Ph. æquivalvis*, Goldf., which has (see p. 79) repeatedly been described as a *Cardium* has not the hinge of any of the *CARDIIDÆ*, but that of *Pholadomya*. I have seen specimens of it which hardly gape at all posteriorly, so that this character can be of no great value in the Texas *Card. elegantulum* of Römer. For my own part I cannot suppress my great doubts as to the propriety of the so-called *Liopistha*, though looking at the various forms of *Papyridea* and others described under *Didacna*, *Monodacna*, &c., there is nothing impossible in Conrad's statement.

3. *Lævicardium*, Swains., 1840. Shells obliquely cordate, more or less inflated, usually solid, with the radiating ribs on the surface small and thin, sometimes hardly traceable, especially at the anterior and posterior end; hinge line curved, teeth stout, distinct, but not very prominent; muscular impressions very large, the posterior especially so; pallial line truncate or very slightly sinuated. *Card. oblongum*, Chem., is one of the best known and typical forms already quoted by Swainson. Species of *Lævicardium* (proper) are rare in the mesozoic strata; they mostly appear to be represented from the tertiary upwards, while in former times they seem to be replaced by the next.

4. *Protocardium*, Beyrich, 1845, (Zeitsch. f. Malakozoologie, p. 17). Shell obliquely cordate, varying in length exactly like *Lævicardium*, outer surface concentrically striated or ribbed, except on the posterior half or so, where radiating ribs occur; hinge typical; posterior muscular impression very large, and in some species the shell below it peculiarly flattened or even slightly impressed; type, *Card. hillanum*, Sow., from cretaceous rocks. In this species Beyrich particularly notices the posterior sinus of the pallial impression, it being here more distinct than in most other closely allied forms, though even in this species its size is especially due to the peculiar prolongation of the posterior muscular impression. The presence of the sinus is, however, not an essential character of the sub-genus, for there are several species to be noticed in which the pallial line is hardly truncate.

Pachycardium is proposed by Conrad (Am. Journ. of Conch., vol. v, p. 96,) apparently only to include two cretaceous species, *Card. Spilmani*, Con., and *C. bisectum*, Forb. The latter is an Indian species, and I have had therefore full opportunity of testing Mr. Conrad's characteristics. The difference from the type species of *Protocardium* is stated to consist in the greater height in proportion to length of the shell; all the other characters mentioned by Conrad are a repetition of those of *P. hillanum*, and partially also of the recent *Lævicardium*. The height in proportion to length of *C. bisectum* is certainly not of a generic or sub-generic importance, as clearly illustrated by the second species *Protoc. Pondicheriense*, which is intermediate between it and *P. hillanum*. We have in such species only perfectly similar changes of form as, for instance, we observe in *Læv. serratum* and *Norvegicum*, and several others.

The recent *Cardium Æolicum*, Born, (= *pectinatum*, Linn.) and *C. lyratum*, Sow., are the representatives of the fossil *Protocardia*; and the eocene forms, as *Card. parile*, *C. fraudator*, Deshayes, (Paris fossils, 2nd edit., Atlas, pl. 54), which have the radiating striæ markedly stronger on the posterior end than on the rest of the surface, are intermediate between the mesozoic *Protocardia* and the recent *Lævicardia*, but as they possess striæ on the entire surface, and as the inner margins of the shell are crenulated accordingly, they are nearer *Lævicardium* than *Protocardium*; all of them belong, however, only to one and the same type of shells.

5. *Serripes*, Beck, 1844. Shell broadly cordate, moderately thin, surface smooth or nearly so, inner marginal edge not or very slightly crenulated, cardinal

teeth small and almost obsolete in full grown specimens. The type of this sub-genus is *C. Grænlædicum*, Chem., the animal of which has the foot with a serrated edge near its angularly bent base. The only other species Römer admits under *Serripes* is *C. Mortoni*, Con., which by its usually finely radiately ribbed shell distinctly indicates a transition to *Lævicardium*. Species of the type of *Serripes* already occur in jurassic rocks, as indicated by *C. septiferum*, Buvign., (Stat. de la Meuse), which is, however, rather a thick shell. From cretaceous rocks I may mention *Card. Dupinianum*, d'Orb., and others, but from tertiary deposits there is hardly one species which could be referred to the genus.

6. *Fragum*, Bolt., 1798. Shell sub-cordate, more or less solid, with a more or less distinct ridge running from the beak to the postero-inferior termination, posterior end broadly truncated, slightly gaping or closed; hinge line anteriorly curved, posteriorly straight; surface radiately ribbed, ribs with peculiar concentric scale-like tubercles, more pointed or spinous in young stages than in old ones. Type, *Card. unedo*, Linn. As far as known, species of this type are first met with in cretaceous rocks, but they are rare; their number increases slowly up to the present time.

H. and A. Adams' *Ctenocardium* should not be separated from *Fragum*. Römer refers the so-called *Cardium australe* (and *donaciforme*) to this genus, but I am very much inclined to believe that that species should be referred to the *DONACIDÆ*; its cardinal teeth are not those of one of the *CARDIIDÆ*, but entirely agree with those of the former family, and the same applies to the lateral teeth; the general form of the shell also agrees with *Donax*.

7. *Hemicardium*, Klein, 1757, (*Corculum*, Bolten, apud Römer). Shell thin, higher than long, heart-shaped from front or behind, laterally with a very prominent ridge running from the umbones to the inferior pointed margin, surface radiately ribbed; ligament very short; cardinal teeth of right valve more or less distinctly united; anterior laterals small; posterior more or less elongated, especially in some of the eocene species with the posterior hinge margin rather straight, as in *Hem. aviculare*, Lam., (*Lithocardium aviculare*, apud Woodward, Man., p. 454). In this and a few other allied tertiary species the anterior laterals are almost obsolete and the anterior muscular impression very small; type, *Card. Cardissa*, Linn.

8. *Lunulicardium*, Gray, 1853. Shell cordate, moderately solid, inflated, with a ridge extending from the umbones to the infero-posterior margin, surface radiately ribbed; lunula below the umbones deeply excavated; cardinal teeth in right valve grown together into a single horizontally flattened tooth fitting between two similarly flattened teeth of the left valve, posterior lateral teeth close to the cardinal; anterior muscular impression elevated; type, *C. retusum*, Linn.

I am not aware that any fossil species belonging to this genus have as yet been found, but the type of the shells appears to be very old. It is possible that some of them may be discovered among the numerous species of *Opis* described from mesozoic beds. An old representative of *Hemicardium* we find apparently in the next genus.

9. *Conocardium*, Bronn, 1835, (Leth. Geog., vol. i, pt. i, 1st edit., p. 91; *Pleurorhynchus*, Phill., 1836, M^cCoy, 1844, &c.). Shell high, short, with the beaks more or less distinctly carinated, incurved and approximate as in *Hemicardia*, surface radiately ribbed, inner edge crenulated or toothed; hinge-line straight, long, anteriorly generally less, posteriorly more produced and gaping at the end; hinge of right valve in the type species, *C. aliforme*, Sow., with an obtuse, thick, double cardinal tooth in front of a pit, posterior lateral tooth remote, lamelliform, anterior not known; species of *Conocardium* are as yet only known from palæozoic rocks; they, however, require to be re-examined in order to fix the hinge characters of the genus.

10. *Goldfussia*, Castelnau, 1843, (Syst. Sil. Amer. sept., p. 43), is based upon *Cardium nautiloides*, each valve of which is said to resemble a laterally compressed Nautilus, keeled on either side. Philippi mentions (Handbuch., &c., p. 339,) this genus in the *CARDIIDÆ*; I have not been able to get access to the original publication of the species.

11. *Lunulicardium*, Münst., 1840, (*Lunulacardium*, Beiträge zur Petrefact.-Kunde, part iii, p. 69). This name has been proposed for a number of devonian species, which in general aspect greatly resemble some species of *Radula*, (*Lima*). The shells are usually higher than long, narrow near the hinge, and with a very deeply excavated lunular (or areal) declivity, beaks pointed, close together, surface radiately ribbed; type, *L. semistriatum*, Münster, (ibid, pl. xiii, fig. 9). I never had an opportunity of examining any of the species called by Münster *Lunulicardium*; the hinge is not known, and I greatly suspect they will prove to be allied to *Radula*, or some *MYTILIDÆ*, though in external form they slightly resemble some *CARDIINÆ*.

b. Sub-family,—*LYMNOCARDIINÆ* (see p. 205).

12. *Lymnocardium*, Stol., 1870. Shell elongated, inequivalve, with the anterior side shorter, moderately inflated and rather thin, surface radiately ribbed, cardinal teeth two, or one in each valve, small, and sometimes quite obsolete, lateral teeth remote, more or less lamelliform, pallial line either entire or (rarely) sinuated, posterior gape usually distinct. Type, *Card. Haueri*,* Hörnes, (Foss. Mollusken d. Wien. Tert., vol. ii, p. 198, pl. 29, fig. 1).

* This is, besides *C. Schmidt* (not *Smidti*), *Hungaricum*, *Mayeri*, &c., &c., one of the species which Conrad quotes (Am. Jour. Conch., 1866, vol. ii, p. 103,) under his genus *Pseudocardia*, the name of which the same author subsequently (Am. Jour. Conch., 1868, iv, p. 246,) replaced by *Vetocardia*. When giving the characteristics of the latter, he evidently refers solely to d'Orbigny's cretaceous *Venericardia*, but how it was possible to associate with these forms the first named ones and others described by Hörnes from the uppermost tertiary beds of the Vienna (or rather Hungarian) basin, it is really difficult to understand, and this the more when, after the enumeration of the species, we find the following statement: "a genus which became extinct in the upper cretaceous period"! Such and similar instances clearly show what value we can attach to those new generic propositions which Mr. Conrad makes with the simple object of supporting the (presently) antiquated idea, that certain genera only occur in certain formations, and that with a new formation new forms of life are introduced. The daily experience of the geologist in the field and in the museum shows that the generalisation of such single facts is untenable, though these facts may be under certain conditions quite correct by themselves.

The species referred to this genus are all from the upper tertiary, chiefly fresh-water deposits of Eastern Europe and of Western Asia. I have already pointed out the general characters which seem to justify the conclusion that the animals were of a form similar to those of the next genus.

13. *Didacna*, Eichw., 1838, (Bull. Soc. imp. Mosc., p. 166). Shell elongated, laterally compressed, inequivalve, usually of thin structure, surface radiately ribbed; hinge with one or two cardinal elongated teeth in each valve, sometimes becoming quite obsolete, lateral teeth none; pallial line often sinuated posteriorly; type, *Cardium trigonoides*, Pallas, a recent species from the Caspian sea.

I adopt here the name *Didacna** as the general generic name, not only because it was the first one proposed by Eichwald for this peculiar group of shells, but because it seems to me to be the most appropriate one. In *Didacna* proper the cardinal teeth are scarcely different from those of *Lævicardium*, for in this as in several other *CARDIIDÆ* the upper cardinal tooth of the right valve often becomes nearly obsolete. In Eichwald's *Monodacna* (l. cit., p. 267,) one tooth is said to occur in each valve, but in reality the difference from *Didacna* is scarcely perceptible. As usually, the right valve has one tooth particularly strongly developed, and in the left valve the posterior one is not distinctly separated from the fulcrum. Again, in some forms the anterior cardinal tooth also becomes obsolete or nearly so, but the pit for the laminar tooth of the right valve remains, and we have then *Adacna*, Eichwald, (*ex parte*), of which the author (l. cit., p. 169,) says, "*cardo edentulus aut callus dentis loco, foveola adjecta laminaque post callum elongata, &c.*" In some other forms of *Adacna* the cardinal teeth have become perfectly obsolete; however, even in such case young shells appear to have them indicated. The transition of these forms, called *Didacna*, *Monodacna*, and *Adacna*, is so gradual that it appears really very difficult to fix a limit between one and the other, but if we retain the two last named ones as sub-genera, we must have a new name for those forms which have a laminar cardinal tooth in the right and a simple pit in the left valve. Good series of living species are necessary to settle this question.

LIST OF CRETACEOUS SPECIES OF *CARDIIDÆ*.

With regard to the cretaceous species of this sub-family I could only repeat what I have already stated of several others. Thick shells, especially cast specimens, are objectionable to base specific characters upon.

See Pictet and Campiche, Pal. Suisse, 4^{me} ser., 3^{me} partie, 1866, p. 265, &c.

1.—*C. Aubersonense* is an *Acanthocardium*.

2-3.—*C. Cottaldinum* and *Voltzii* belong apparently to the sub-genus *Pectunculus*.

* H. and A. Adams place *Card. Australiense* and *donaciforme*, which are said by Römer to be only varieties of one and the same species, under *Didacna*. This is, as I already mentioned, a mistake. *Card. donaciforme* has lateral teeth, is a solid apparently purely marine shell, entirely of the *Donax* type, and does not, I think, belong at all to the *CARDIIDÆ*. The entire pallial line seems to be almost the only distinction from *Serrula* and other allied sub-genera of *Donax*. The general character of the shell of the so-called *C. donaciforme* greatly recalls the fossil *Tancredia*, Lyc., (or *Hettangia*, Terq.), which I have described in the *DONACIDÆ*, and it does not appear improbable that this fossil genus is the prototype of the recent forms. Generically they appear to be hardly different.

4-8.—*C. sub-hillanum*, *peregrinum*, *impressum*, *Jaccardi*, and *Germani*; the first and last appear to be referable to *Lævicardium*, the other three are *Protocardia*.

9-10.—*C. Gillieron* and *Valdense* are based upon cast specimens which do not show any trace of radiating striæ or ribs; their form, however, better agrees with *Lævicardium* than with *Serripes*.

11.—*C. imbricatarium* has the form of a *Protocardium*, but apparently no radiating striæ on the posterior declivity, though this is distinctly separated from the rest of the shell by an interior sulcus.

12.—*C. inornatum* may belong to *Serripes*, but if no lateral teeth exist d'Orbigny's subsequent determination as *Unicardium* would appear to be correct. I will mention the species again in the family *LUCINIDÆ*.

13.—*C. sphæroideum* is apparently a *Lævicardium*, or like the next.

14.—*C. Forbesi*, a *Protocardium*.

15.—*C. Ibbetsoni* is a *Lævicardium*.

16.—*C. Bellegardense*, a *Protocardium*.

17.—*C. Benstedii*. The original specimens should be examined; Forbes does not give a characteristic of the species, but merely alludes to its small size and longitudinal (radiating) ribbing. From this the species would appear to be an *Acanthocardium*.

18.—*C. Dupinianum* is a *Serripes*.

19-21.—*C. Constantii*, *Raulinianum*, *alpinum* are species of *Acanthocardium*.

22-24.—*C. hillanum*, *Marticense*, *Guerangeri* belong to *Protocardium*.

25.—*C. Michelini* may be a *Lævicardium*.

26-33.—*C. proboscideum*, *Carolinum*, *Gentianum*, *inæquicostatum*, *Vendinense*, *Cenomanense*, *hypericum*, *canaliculatum* are species of *Acanthocardium*.

34-37.—*C. Mailleanum*, *sub-ventricosum*, *Pelagi*, *concentricum* belong to *Lævicardium*.

38.—*C. Requierianum* is to all appearance identical with *Protocardium hillanum*, as stated by Zittel, and others.

39-41.—*C. productum*, *intercostatum*, *bispinosum* are *Acanthocardia*.

42.—*C. Cordierianum* is a *Protocardium*.

43-47.—*C. sub-guttiferum*, *Corbierense*, *atacense*, and perhaps also *Toucasianum* and *Faujasi* are *Acanthocardia*.

48.—*C. coniacum* is a *Cerastoderma*.

49.—*C. Rochebruni* is based upon an insufficient cast.

50.—*C. bimarginatum* is an *Acanthocardium*.

51.—*C. Raulini* may be a *Lævicardium*, but the description is not satisfactory.

52.—*C. insculptum*; the figure of this species looks more like that of a *Linearia* (*TELLINIDÆ*) than of any of the *CARDIINÆ*.

53.—*C. radiatum* seems to be a *Cerastoderma*.

54-57.—*C. Villeneuvevianum*, *Itierianum*, and apparently also *C. pisolithicum* and *Dutempleanum* are *Acanthocardia*.

58.—*C. corrugatum* is a *Protocardium*.

59-60.—*C. Olisiponense* and *tubuliferum* are *Acanthocardia*.

61-62.—*C. semipapillatum* and *lineolatum*; the first is insufficiently known, the second may be an *Acanthocardium* (see Favre Descript. Moll. foss., Lemberg, 1869, p. 113).

63-64.—*C. alutaceum* and *pustulosum* are *Acanthocardia*.

65.—*C. Ottoi* is a *Cerastoderma*.

66.—*C. intermedium* (? *productum*) is an *Acanthocardium*.

67.—*C. propinquum* is a *Cerastoderma*.

68-69.—*C. fenestratum* and *granigerum* apparently belong to *Acanthocardium*; with the first Alth.'s *C. polonicum* is identical (see Favre Descript. Moll. foss., Lemberg, 1869, p. 114).

70-71.—*C. Becksii* and *semipustulosum* belong to *Acanthocardium*.

72.—*C. Debeyanum* is a *Schizodesma* (*MACTRIDÆ*, vide p. 55).

73.—*C. Marguarti* is an *Acanthocardium*.

74.—*C. gibbosum* does not appear to be different from *C. Becksii*; there is no difference to be observed in the ribbing, and the slightly higher form does not seem to indicate more than an ordinary variation.

75.—*C. Noeggerathii* is a *Lævicardium*, and the same is apparently the case with the two next species.

76-77.—*C. Gosaviense* and *Reussi*.

78.—*Protocardium Petersi*, Zittel.

79.—*C. Bredai*, Müller, (Petref. Aach. Kreidef. Supplem., 1859, p. 12, pl. 7, fig. 16); the form is that of an *Acanthocardium*, but the surface, if natural as described, would indicate a *Lævicardium*.

80-81.—*C. Benedeni* and *pectiniforme*, Müller, are mentioned by Bosquet in extract from Staring's Bodem v. Nederland, pt. ii, (Foss. fauna and flora v. Limburg); I am not acquainted with these species.

Coquand (Mon. Étage Aptien de l'Espagne, 1865, p. 117, &c., describes the following seven new species:—

82-84.—*C. Janus*, *comes*, and *miles* are *Protocardia*.

85-86.—*C. Euryalus* and *bidorsatum* are either not well preserved forms of *Acanthocardium*, or they belong to *Lævicardium*.

87.—*C. Amphitritis* is an insufficient cast, which may belong to a *Lævicardium*, but has more the form of a *Cucullæa*.

88.—*C. amœnum* is to all appearance a *Cerastoderma*.

89.—*C. lève*, Guéranger, (Album paléont. de la Sarthe, 1867, pl. xx, figs. 4 and 6,) appears to be a *Lævicardium*.

From Eichwald (Leth. ross., livr. xi, 1867, p. 680, &c.) the following species have to be referred to, but the formations to which they belong do not appear to be satisfactorily determined.

90.—*C. boreale* is apparently a *Cerastoderma*, or the sub-genus *Pectunculus*.

91-94.—*C. avus*, *armenicum*, *aralense*, and *semigranulatum* are probably *Acanthocardia*; of the two last named the formation is uncertain.

95-96.—*C. petilum* and *verveceum* are described by Lioriol in Mat. p. l. Pal. Suisse, 4^{me} ser., 1868, pp. 26 and 28, from the Valangien beds; the first belongs to *Protocardium*, the second has more the form of a *Cicatrea* (a sub-genus of *Cyprina*), than of any of the true *CARDIINÆ*.

97-99.—*C. crebri-echinatum*, *Syriacum*, and *Hermonense* are described by Conrad from Palæstine; they are based upon insufficient casts, and Fraas believes that they only indicate two species (vide Würt. naturw. Jahreshfte, xxiii, 1867, p. 235, &c.).

100-101.—*C. bellum* and *ovulum* are noticed also by Conrad in Lynch's expedition to Palæstine.

102-114.—*C. Pauli*, *Dutruegi*, *auressense*, *algirum*, *Platonis*, *regulare*, *sulciferum*, *triangulare*, *Desvauxi*, *Vattoni*, *Mermeti*, *Saportæ*, *punicum*, are described by Coquand from the Province Constantine (Geol. and Paleont. Prov. Const., 1862, p. 204, &c.), but as the species are chiefly based upon cast specimens they are not of much value in point of comparison with other fossils; the genera *Acanthocardium*, *Lævicardium*, and *Protocardium* are represented among them.

115.—*C. denticulatum* from South Africa is a typical *Acanthocardium*.

116-142.—Meek mentions the following in his Check-list of invert. cretaceous fossils of North America, (Smiths. Misc. Coll., No. 177, 1864, p. 12),—*C. abruptum*, *Coloradense*, *congestum*, *curtum*, *Eufalense*, *hemicyclum*, *mediale*, *multiradiatum*, *Ripleyense*, *speciosum*, *Tippanum*, *Arkansense*, *Brazoense*, *Choctawense*, *filosum*, *multistriatum*, *pertenue*, *rarum*, *scitulum*, *sub-quadratum*, *Texanum*, *Spillmani*; the last eleven species belong to *Protocardium*, the others to the sub-genus *Acanthocardium*. Besides these are noticed *Papyridea elegantula*, *bella*, (not *Card. bellum*, Con.), *protexta*, *rostrata*, and *sanctisabæ*; the first four being referred to the sub-genus *Liopistha*, but I have already (p. 208) observed that it appears doubtful whether these forms are correctly placed in the *CARDIIDÆ*; some other externally closely allied species undoubtedly belong to *Pholadomya*, and the same may be the case with these few species.

143-149.—*C. Rémondianum*, *Cooperii*, *Brewerii*; *C. (Lævicardium) linteum*, *annulatum*, *C. (Protocardium) Placerense* and *translucidum* are recorded by Gabb from the cretaceous rocks of California (Palæont. Calif., ii, p. 242).

150-152.—*C. subtentum*, *Protocardium gambrinum*, and *Virginianum* are from the so-called lower eocene beds (see Conrad's Check-list, &c., Smiths. Misc. Coll., No. 200, 1866, p. 6).

153-154.—*C. Columbianum* and *acuticostatum*, d'Orb., (Pal. Am. Merid., pp. 82 and 120); the last was first described from beds on Quirquina, said to be tertiary; it has rather a recent aspect and appears to belong to *Cardium* proper, but subsequently d'Orbigny (Prod. ii, p. 242,) referred the species to *Sénonien*.

155.—*C. australinum*, d'Orb., Prod. ii, p. 242, is also from Chili.

156-157.—*C. pederale* and *transversale* from Texas are stated by Römer to be rather insufficiently characterised from existing materials (Kreideb. von Texas und ihre org. Einschlüsse, Bonn, 1852, pp. 49 and 50); the former is a *Protocardium*.

158-159.—*C. sabulosum* and *C. (Prot.) granuliferum* are described from Mexico by Gabb, (Pal. of Calif., ii, p. 267). For the first a new sub-genus, *Granocardium*, has been proposed, which appears quite unnecessary, as already mentioned (p. 207).

160-161.—The Indian species are as follows:—*C. incomptum*, *exulans*, *productum* belong to *Trachycardium*; *C. (Acanthocardium) pullatum*; *C. (Cerastoderma) pilatum*; *C. (? Pectunculus) scrobiculatum*, *Protocardium hillanum*, *delicatulum*, *Pondicheriense*, *altum* and *biseotum*; *Fragum præcurrens*. Of this only *C. productum* and *Protoc. hillanum* are identical with European species.

Looking at this large list of species of *CARDIIDÆ* from cretaceous rocks, we find that the sub-generic forms *Acanthocardium*, *Pectunculus*, and *Trachycardium* are the most common; next comes the peculiar more ancient type *Protocardium*, and then its close ally *Lævicardium*; of *Cerastoderma* there are no more than one-twentieth of the whole number; of *Serripes* and *Fragum* only one or two of each, while *Cardium* as restricted, *Lunulicardium* and *Hemicardium* are not at all represented. As to geographical distribution the list shows that the above noted sub-genera are found wherever cretaceous rocks have been met with, and thus the geographical distribution was then much the same as it is now, of course with the exception of the present arctic regions.

CARDIUM, *Linné* 1758, (see p. 207).1. CARDIUM [TRACHYCARDIUM] INCOMPTUM, *Sowerby*, Pl. XI, Figs. 3-7.1846. *C. incomptum*, Sow., apud Forbes, Trans., Geol. Soc., London, vii, p. 145, pl. 15, fig. 16.1850. *idem*, apud d'Orbigny, Prodrôme, ii, p. 242.

Trach. testa sub-quadrangulari, inflata, altiore quam longa, sub-æquilaterali, antice lente rotundata, declivitate postica abrupta, applanata, ad marginem subrecta; superficie costis 25-30 radiantibus, distantioribus, acutis, confertim spinulose tuberculatis ornata; margine interno crasse dentato; cardine dentibus lateralibus cardinalibus approximatis, omninis crassissimis instructo.

Height of shell	:	its length	...	...	...	...	1.18
Thickness	„	:	„	...	...	...	0.94

The shell of this species is sub-quadrangular in shape, like *Acanthocardium*, but the hinge-line is short and the lateral teeth very close to the cardinal, as in typical *Trachycardium*. The valves are strongly inflated, anteriorly gradually, posteriorly somewhat abruptly, sloping and truncated. The surface is ornamented with from 25-30 sharp prominent and spinous ribs, less spiny on the posterior declivity; the furrows are equally broad or, near the periphery, broader than the ribs. Old specimens (figs. 3 and 4) have usually the ribs not so distinctly tuberculated as young ones, and sometimes they must have been greatly rolled before being buried in the rock (see fig. 5).

Zittel identifies this species with *Card. Ottoi*, Geinitz, (Denksch. Akad., Wien., xxiv, pt. ii, p. 144), but the reason does not seem apparent, for the figure given by Forbes scarcely admits of any identification with a known species, and in the description Forbes only mentions, "*costis sub-squamosis*." I have compared both the original specimens; they are in a bad state of preservation, but clearly belong to the present species.

Localities.—Neighbourhood of *Anapady*, near Garudamungalum and Serdamungalum, in a brownish calcareous rock, evidently formed of the detritus of coral reefs; common.

Formation.—Trichinopoly group.

✓ 2. CARDIUM [TRACHYCARDIUM] EXULANS, *Stoliczka*, Pl. XI, Figs. 11-13.

Trach. testa parva, multo altiore quam longa, sub-æquilaterali, antice lente rotundata postice late sub-truncata, umbonibus angustis, prominulis, incurvis instructa, ab umbonibus ad marginem infero-posteriorem obtuse angulata, in superficie costis 35-40 radiantibus, æqualibus obsolete granulosis, obtusis, sulcis angustissimis separatis ornata; margine interno dentato; lunula haud distincta; cardine dentibus lateralibus cardinalibus valde approximatis instructo.

Height of shell	:	its length	...	...	...	...	1.41
Thickness	„	:	„	...	...	...	1.09

This species is readily distinguished by its remarkable great height as compared with its length, and by the obtuse ridge running from the apex to the infero-

posterior angle of the periphery; the surface is ornamented by numerous (35-40) closely set radiating ribs, which are only very slightly tuberculated; in some specimens they appear almost smooth. The short hinge-line characterizes this form as a *Trachycardium*.

When the surface of the shell is worn off the ribs sometimes become bifid, but their abnormal state is readily traced.

Localities.—South-east of Arrialoor and at Olapaudy; very common at the former in a light coloured soft sandstone; the largest specimen measures about 40 m.m. in height.

Formation.—Arrialoor group.

✓ 3. CARD. [TRACHYCARDIUM] PRODUCTUM, *Sowerby*, Pl. XI, Figs. 15-16.

1832. *C. productum*, Sow., Trans., Geol. Soc., London, iii, p. 417, pl. 39, fig. 15.

1865. *idem* apud Zittel, Denksch. Akad., Wien, xxiv, pt. 2, p. 140, pl. 5, fig. 4,—*cum synonym*.

Trach. testa crassa, valde inflata, sub-quadrangulari, altiore quam longa, margine antico ac postico fere parallelis, infero convexiusculo, verticibus valde prominentibus et incurvatis. Superficie costis radiantibus numerosis ad medium leviter furcatis unilateraliter spinulose tuberculatis sulcis angustis disjunctis instructa; area cardinali curvata, dentibus lateralibus ab cardinalibus moderate remotis, omninis crassis.

Height of shell	:	its length	...	...	...	...	1.25
Thickness	„	„	...	...	...	...	0.98

This species is so well known that it is unnecessary to add anything to the above description. The statement, however, that not the ribs but the intervening sulci are spinulose or tuberculated rests, I believe, upon a mistake. The fact seems to me that the tubercles or spines are situated only on one side of the ribs, reaching down to the base of the adjoining furrow, and pointing either towards the anterior or the posterior end. When the surface of the shell is somewhat eroded the tubercles very easily wear off on the ribs, but they remain preserved in the adjoining furrows, thus giving the impression that they were originally and solely situated in them. A perfectly similar case can be observed on the recent *Card. [Trachycardium] elongatum*, Sow.

The species occurs from the Cenomanien up to the Sénonien beds, almost throughout Europe, in Germany, Belgium, France, and throughout the Alpine Gosau deposits; it is one of the cosmopolitan species, like *Protocardium hillanum*.

Locality.—Koloture, in a brownish calcareous sandstone; apparently rare.

Formation.—Ootatoor group.

✓ 4. CARDIUM [ACANTHOCARDIUM] PULLATUM, *Stoliczka*, Pl. XI, Figs. 8-10.

Acanth. testa parvula, rotundate quadrangulati, valde inflata, clausa, fere æquilaterali, antice ad marginem lente curvata, postice sub-recta; superficie costulis circiter 28-30 radiantibus, æquidistantibus, acutiusculis, tuberculis numerosis sub-spinulosis notatis ornata; area cardinali moderate curvata, dentibus regularibus instructa.

Height of shell	:	its length	...	...	...	...	0.92
Thickness	„	:	„	...	...	...	1.00-0.95

This species has in general character a much greater resemblance to *C. Ottoi*, Geinitz, than the last, but the former has the radiating ribs ornamented with transverse thin lamellæ, not with tubercles, as in *C. pullatum*, and is also somewhat less inflated than the present species. When the surface of the shell is a little worn off, the ribs appear to be almost smooth (fig. 9), and then the form of the shell becomes more rounded. The hinge-teeth are of moderate size and sharply pointed.

Localities.—Neighbourhood of Vylapady and Anapady, partially in a brownish calcareous rock, partially in light coloured sandstone; rather rare.

Formation.—Trichinopoly group.

✓ 5. CARDIUM [CERASTODERMA] PILATUM, *Stoliczka*, Pl. XIII, Figs. 6-7.

Cerast. testa sub-orbiculata, moderate inflata, inæquilaterali, tenui, postice late rotundata; superficie costulis radiantibus numerosissimis, latiusculis, sub-lævigatis, interdum squamulose granulatis sulcis angustissimis disjunctis ornata; lunula læviscula, extus haud marginata; cardine dentibus cardinalibus parvis, lateralibus lamellosis instructo.

Height of shell	:	its length	...	...	...	...	0.95
Thickness	„	:	„	(approximately)	...	...	0.78

This is the only South Indian species which appears to belong to the sub-genus *Cerastoderma*, though it is rather too much rounded, but it is distinctly considerably shorter anteriorly than posteriorly. The surface is ornamented with very numerous flattened radiating ribs, separated by grooves much narrower than the ribs; these are in young specimens ornamented with fine lamellar tubercles, which seem to become obsolete with age; the lunula is smooth.

Locality.—Ninnyoor, in white soft limestone.

Formation.—Arrialoor group.

✓ 6. CARDIUM [? PECTUNCULUS] SCROBICULATUM, *Stoliczka*, Pl. XI, Fig. 14.

C. (? Pect.) testa parvula, rotundate quadrangulari, sub-equilaterali antice distincter, inflata, in utroque latere fere æqualiter convexa; infra ac postice lentissime curvata, seu sub-truncata, umbonibus prominulis, latis, incurvis, superficie polita, sub-lævigata, striis concentricis ac radiantibus minutissimis ac confertissimis, vix conspicuis, notata.

Height of shell	:	its length	...	...	...	1.08
Thickness	„	:	„	...	...	(approximately) 0.77

This small species is characterized by its somewhat greater or equal height in proportion to length, rather strong convexity,* and the polished surface, which to the eye only appears to be minutely punctured. However, under the lens very fine decussating striæ can be observed, and when the glazed surface of the shell is removed the radiating lines become well visible. Though the few specimens examined are small, they do not appear to belong to a particularly young shell, but to a naturally small species. It is possible that the species is a *Lævicardium*, but more specimens are required before that question can be satisfactorily answered.

Locality.—Garudamungalum, in bluish calcareous sandstone, with various small species of shells; rare.

Formation.—Trichinopoly group.

PROTOCARDIUM, *Beyrich*, 1847, (vide p. 209).✓ 1. PROTOCARDIUM HILLANUM, *Sowerby*, Pl. XII, Figs. 8-10, and Pl. XIII, Figs. 1-3.

1813. *Cardium hillanum*, Sow., Min. Conch., i, p. 41.

1865. „ „ apud Zittel, Denksch. Acad., Wien, xxiv, pt. 2, p. 146, —*cum synon.*

Prot. testa crassa, sub-rotundata, sub-æquilaterali, umbonibus paulo prominentibus, obtusatis, incurvis, approximatis instructa, antice ac infra rotundata, postice oblique truncata; superficie costulis concentricis confertissimis approximatis lævigatis et in regione postica 12-18 costis radiantibus, distantioribus prope marginem superiorem obsolete ornata; fulcris incrassatis; impressionibus muscularibus profundis; sinu pallii postico parvo.

Height of shell	:	its length	...	...	...	varying from 0.80-0.94
Thickness	„	:	„	...	...	„ „ 0.61-0.77

There is, as already recorded by Prof. Forbes, no difference to be observed between specimens from Europe and those from South India; they agree in every

* It ought to be about $1\frac{1}{2}$ m. m. more than shown in figure 14a; and in fig. 14 the posterior margin should be slightly more truncate.

respect with each other, and whatever slight variations there are to be observed in the coarseness of the concentric or radiating ribs they are common to both.

Localities.—Garudamungalum, Serdamungalum, Alundanapooram, Anapaudy, &c.; very common; either in a bluish calcareous sandstone or more frequently occurring in a brownish earthy limestone, sometimes passing into a conglomeratic rock.

Formation.—Trichinopoly group.

In Europe the species is found almost everywhere in Cenomanien, Turonien, and Sénonien deposits, particularly, however, in the middle series. It is also recorded by Prof. F. Römer from Texas, but the figure given of one of the specimens would, I think, indicate a different species with the anterior (especially the lower) edge shorter and the ribs more distant.

2. PROTOCARDIUM DELICATULUM, *Stoliczka*, Pl. XIII, Fig. 8.

Prot. testa tæniolata, sub-orbiculata, moderate convexa, postice sub-truncata, umbonibus prominentibus, lateraliter compressis; superficie concentrice lente striata, postice radiatim multi-costulata.

Height of shell : its length ...	...	...	...	...	1.02
Thickness „ : „ ...	...	...	...	(approximately)	0.68

This species is closely allied to *Prot. hillanum*, but is decidedly higher, with more prominent umbones, more numerous ribs on the posterior declivity and altogether of a thinner structure.

Locality.—Shutamungalum, in a light grey sandstone, apparently belonging to the upper series of the cretaceous deposits.

Formation.—? Arriallor group.

3. PROTOCARDIUM PONDICHERIENSE, *d'Orbigny*, Pl. XII, Figs. 4-7.

1847. *Cardium Ponticeriense*, d'Orb., Voyage Astrolabe, &c., Palæont., pl. 5, figs. 21-22.

Prot. testa sub-trigonata, moderate inflata, crassa, paulo altiore quam longa, sub-æquilaterali, sub-recta; umbonibus valde prominentibus, lateraliter compressis, incurvis instructa, antice ac infra ad marginem lente rotundata, postice oblique truncata, vix producta; superficie costis concentricis crassis, rotundatis in declivitate antica sæpissime sub-obsoletis notata; declivitate postica costis 20-24 radiantibus paulo prominulis confertim tecta, ad marginem interiorem denticulata. Cardo dentibus crassis sicut in speciebus typicis instructus.

Height of shell : its length ...	...	...	...	...	1.02
Thickness „ : „ ...	...	...	...	...	0.83

As to form this species is intermediate between *Prot. hillanum* and *Prot. altum*, being more regularly triangular and less high than the latter; the concentric

striation is obsolete or nearly so on the anterior declivity, and the ribs on the posterior declivity are numerous, close together and rather indistinct; near the thickened fulcra they are as usual quite obsolete.

The species has been first figured by d'Orbigny in the Paléontology of the Voyage of the Astrolabe and Zeleé, but subsequently (Prod. ii, p. 242,) the same author considered it as identical with the next species, from which, however, the distinctions become readily apparent by a comparison of the figures.

Localities.—Anapaudy, Alundanapooram, &c.; not uncommon.

Formation.—Trichinopoly group.

✓ 4. *PROTOCARDIUM ALTUM*, Sowerby, Pl. XII, Figs. 1 and 3.

1846. *Cardium altum*, Sow., apud Forbes, Trans., Geol. Soc., London, vii, p. 145, pl. 15, fig. 13—*idem* auctorum.

Prot. testa oblique sub-trigonata, crassa, altiore quam longa, moderate inflata, lunula paulo excavata, antice et infra ad marginem rotundata, postice sub-truncata, margine postico superiori oblique descendenti, recto; superficie lamellose costulata, costis in parte antica obsoletis interdumque lineis filiformibus radiantibus substitutis; costulis in declivitate postica sitis confertissimis, inferioribus magis distinctis quam superioribus. Cardio dentibus crassis regularibus instructus.

Height of shell	:	its length	...	...	...	1.10 - 1.20
Thickness	„	:	„	...	...	0.80 - 0.85

In this species the concentric lamellar ribs are about the middle of the shell, obsolete on a larger area than in the last, and moreover they are sometimes replaced by more or less distinct, but usually very fine undulating radiating striae. The lunula is somewhat excavated, and the posterior hinge line particularly straight and descending. The shell is, as already stated, more oblique and higher than the last species, while the smaller extension of the posterior area readily separates it from *Prot. bisectum*.

Locality.—Monglepaudy, Odium, Ootatoor; not common.

Formation.—Ootatoor group.

✓ 5. *PROTOCARDIUM BISECTUM*, Forbes, Pl. XII, Fig. 2.

1846. *Card. bisectum*, Forb., Trans., Geol. Soc., London, vii, p. 144, pl. 17, fig. 9—*idem* auctorum.

Prot. testa multo altiore quam longa, valde inflata, moderate crassa, umbonibus valde prominentibus, incurvis, fere contiguis, angustis, antice leviter convexa, postice truncata; margine postero-inferiori moderate producto, lunula paulo excavata; superficie in dimidio antico concentrice subtiliter striata, in postico radiatim costellata.

Height of shell	:	its length	...	...	...	1.40
Thickness	„	:	„	...	...	1.13

The great height of the shell in proportion to its length, and the whole of the posterior half of the surface being occupied by radiating ribs, readily distinguish

this peculiar form from any other known. The concentric striæ are very distinct, especially on the strong convexity near the umbones; they are less so in the middle, but become again more strongly marked near the periphery. The radiating ribs are numerous, close together, and also traceable on the internal surface of the shell.

Locality.—Monglepaudy and Ootatoor, in a grey calcareous sandstone; apparently a rare shell.

Formation.—Ootatoor group.

FRAGUM, *Bolten*, 1798 (vide p. 210).

✓1. FRAGUM PRÆCURRENS, *Stoliczka*, Pl. XI, Figs. 1-2.

Frag. testa oblique sub-quadrangulari, sub-cordata, solida, umbonibus latiusculis, prominulis, valde incurvis, sub-medianis, antice angustatim rotundata, infra lente convexa, postice rectiuscule ac oblique truncata; in superficie costis 35-45 radiantibus sub-æqualibus, sulcis profundis angustissimis disjunctis, ornata; costis anticis ac lateralibus, seu medianis, in junioribus speciminibus lamellose-, in adultis sub-rotundate-tuberculosis, iis in declivitate postica sitis distantioribus et sub-lævigatis; lunula angusta, lævigata; fulcris crassis, prominulis; margine interno crasse dentato; cardine dentibus cardinalibus et lateralibus sicut in speciminibus typicis instructo; impressione palliali postice conspicue truncata seu lente sinuata.

Height of shell	:	its length	...	...	...	0.80
Thickness	„	:	„	...	...	0.70

This is a typical species of the sub-genus *Fragum*, which has scarcely been known before from cretaceous rocks. The form is longer and less high than most of the recent species, and the radiating ribs are hardly tuberculated at all on the posterior declivity; the shell close below the posterior muscular impression is strongly thickened and the pallial line is truncated or slightly sinuated posteriorly; in every other respect it agrees with the type species of the above genus.

Locality.—In calcareous sandstone north of Odium and west of Anapaudy; at the last named locality chiefly small specimens, but in very large numbers, occur. They are extremely like a little species which lives at present very abundantly on the coral reefs of the Nicobar islands, and apparently never grows to a large size.

Formation.—Ootatoor group.

V. Order,—**CHAMACEA**.

The families which are here included in a separate order under the above name are five, the *VERTICORDIIDÆ*, *TRIDACNIDÆ*, *CHAMIDÆ*, *CHAMOSTREIDÆ*, and *HIPPURITIDÆ*. With the exception of the last, each has, at least, one living representative, though the whole order appears to have had its greatest development during the later times of the mesozoic period. Several important characters in the organisation of the animals and of the shells make this order a very natural group of Pelecypoda.

The animals are distinguished by their thick, generally rounded form, with a double edge to the mantle, the inner one of which is united, the outer free, thickened, and often provided with, or produced into, different kinds of appendages or filaments. The inner united mantle has one opening for a small, more or less rudimentary foot, and two for the siphons, which are slightly, or not at all, produced, but always separated and often with one or both of their orifices fringed. The thickened free edges of the mantle secrete the usual manifold sharp ornamentation of the shells which possess a reticulated structure, and are often traversed by various anastomosing canals. The gills and labial palps are usually of small size; in the former the inner pair of gills is generally smaller than the outer, and sometimes nearly obsolete.

The shells are solid, thick, generally inequivalve, the larger valve being usually partially attached, and one or both are richly ornamented with lamellæ or spines. The hinge consists generally of few large teeth, the muscular impressions are often on elevated ridges and of great size, the pallial impression entire (or ? sinuated in *HIPPURITIDÆ*); the ligament external, sometimes obsolete; an internal cartilage is present in some families.

The *CHAMIDÆ* which at present form the most extensive family of this order have often been, more or less, closely associated with the *CARDIIDÆ*, but there is actually very little resemblance between them, except that the rich spiny ornamentation is often common to both. The organisation of the animals with their united mantle margins separates them widely from all the *VENERACEA*, and equally so the structure of the outer layer of the shells. It is indeed very difficult to assign to the present order a natural place in a systematic arrangement of the Pelecypoda. The animals appear to combine the characters of the *MYACEA* and *VENERACEA*, possessing the united mantle and small foot of the former, and the short separated siphons of the latter. But as the former character seems to me to be the more important one upon which our system should be based, I think the relation to the first family is greater than to the second.

The shells of the other families are by the small number and the arrangement of the hinge-teeth, by the frequent occurrence of an internal cartilage, and the occasional internal pearly structure also in favor of this classification; and thus, properly speaking, the *CHAMACEA* could be considered as abnormal forms of the *MYACEA*, especially recalling some of the large *Corbulæ* and allied genera. Were it not apparently very unnatural to break up the series of connecting links

between the *SOLENIIDÆ* and the *TELLINACEA* and from these again to the *VENERACEA*, I should have certainly classed the present order immediately after the *MYACEA*; but considering our present materials, I prefer to look upon the former named three orders rather as belonging to one series of shells, and provisionally to separate the *CHAMACEA* from them. However, it cannot be doubted, I think, that the relations pointed out are to a great extent correct, and when particularly the very numerous fossil *MYACEA* and also the *CHAMACEA* have been better studied, the classification of the one next to the other will most likely be found the most natural one.

Pictet and Campiche, in their recent classification of the cretaceous Pelecypoda of Sainte-Croix (Pal. Suisse, 5^{me} ser., 4^{me} partie, 1868), propose a distinct order for the *CHAMACEA* under the name of "*Pleuroconques Dimyaires*" as equivalent to their two other orders, "*Acéphales orthoconques*" and "*A. monomyaires*." I confess, I do not see either in the organization of the animals or shells anything to support this grand division.

All the recent *CHAMACEA* are littoral, living attached to rocks, or on coral-reefs; the fossil *HIPPURITIDÆ* often formed extensive banks similar to those of oysters; they belong with few exceptions to the fauna of tropical seas, and are all purely marine inhabitants. The total number of known recent species is about 75; in the tertiary period it is considerably smaller, but in the cretaceous period it is more than double, very rapidly decreasing again in the jurassic period.

XVIII. Family,—*VERTICORDIIDÆ*.

Shells equivalve, or nearly so, of small size, inflated, with the beaks incurved, closed all round, more or less solid, pearly inside; hinge with few cardinal teeth more or less obsolete, ligament sub-internal or internal; two muscular impressions, pallial line simple. The three genera which I propose to include in the present family under the above mentioned characteristic are *Pecchiolia*, *Verticordia*, and *Allopagus*, the last being proposed for the species *Hippagus Leanus* of Deshayes, as it does not belong to Lea's genus, which I shall point out further on.

Of these three genera we have only lately* become acquainted with the animal of *Verticordia*, the other two genera being as yet known only in the fossil state.

The animal of *V. Japonica*, A. Ad., has the mantle margins united, with a small anterior opening for the protrusion of the foot, which is small, triangular, compressed, and a posterior roundish, fringed opening in which are enclosed two separated but very short siphons; labial palps small.

Mr. Adams justly observes that *Verticordia* has no relation to *Trigonia* with regard to the organisation of the animal, and that it is more closely allied to *Glossus* (= *Isocardia*). Considering the form of the siphons in *Verticordia* and the general character in the form of the shell, this classification would certainly appear

* Ann. Mag. Nat. Hist., 1862, vol. ix, p. 224.

more correct than the one adopted by H. and A. Adams, Chenu, or Deshayes, but looking at the other peculiarities pointed out previously as regards the united mantle margins, short foot, small labial palps, &c., and again the relations of the shells to those of the *CHAMIDÆ*, the distinct grouping in the order *CHAMACEA* appears to me to be best in accordance with our present knowledge of these shells.

The characters of the three genera are briefly as follows:—

1. *Verticordia*, S. Wood, 1844. Shell sub-orbicular, equivalve, of small size, moderately thickened, more or less inflated, with pointed incurved beaks, surface with radiating ribs, sometimes besides ornamented with granules, covered with a brown epidermis; hinge with one small cardinal tooth in each valve below the beaks, somewhat prolonged internally along the inner lunular edge, and in one or the other valve this inner rim is occasionally interrupted so as to represent one strictly cardinal and one sub-lunular tooth; the posterior edge of the shell is generally occupied by a raised rim internally, which supports the internal linear ligament. The type of the genus is *V. ornata*, d'Orb., and besides this four other recent and four (tertiary) fossil species have been described, (vide Journ. de Conchyliol., 1862, vol. x, p. 380).

2. *Pecchiolia*, Menegh., 1851, (vide Hörnes' foss. Moll. des tert. Beckens von Wien, vol. ii, p. 168). Shell sub-orbicular, equivalve, strongly ventricose, with the beaks incurved and distant from each other, surface radiately sulcated and ribbed; hinge in the right valve with a strong cardinal tooth below the umbo, a corresponding indentation in the left valve; ligament apparently linear, situated along the upper posterior margin.

The tooth of the right valve is supposed to have supported an internal cartilage, but there is no certain proof of this; it in form greatly resembles that of a *Chama*. On the whole, the character of the shell is that of a large solid *Verticordia*, except that the left valve has no trace of a special tooth, and the posterior rim for the support of the ligament is almost obsolete, but indicated by a groove in the margin of the left valve. Only a single miocene species, *P. argentea*, is as yet known.

3. *Allopagus*, Stoliczka, 1870. (*Hippagus*, apud Deshayes, non Lea, Descript. des foss. du bas. de Paris, 2nd ed., vol. i, p. 809). Shell ovate, thin, very inequilateral, moderately tumid, with small approximate beaks; surface smooth with simple striæ of increase; right valve with one tooth in front of the umbo, left with a similar tooth below the umbo; ligament sub-internal, posterior. The type of this genus is *Hippagus Leanus*, Deshayes, l. cit., p. 810, pl. 51, figs. 1-3. The species differs by the hinge and the structure of its shell from *Hippagus*,—Lea's original figure of *H. isocardioides* being apparently quite correct,—the latter genus belonging to all appearance close to *Mysia* in the *UNGULINIDÆ*. Deshayes' species is externally very like a *Mytilimeria*, but this again accords in the character of its hinge with true *Hippagus*.

No cretaceous species of any of the *VERTICORDIIDÆ* have as yet been found, nor are there any distinct indications of their occurrence in older deposits.

XIX. *Family*,—*TRIDACNIDÆ*.

The animals are characterized by an entirely closed mantle with thickened margins, the external fringes of which are free, the two siphonal openings are separated and situated on the lower side, usually with the margins fringed, the pedal opening is in front of the beaks corresponding to a more or less distinct opening of the shell; the foot is small and cylindrical; mouth with long narrow lips, at the end of each of which there is a pair of pointed labial palps; gills two on each side.

The shells are usually equivalve, free, often enclosed in growing coral, solid, sub-triangular, rather elongated, tumid, rarely smooth, mostly on the surface strongly radiately ribbed and concentrically lamellar or striated; the beaks are incurved and close together; the lunula is more or less opened and flattened, ligament linear situated along the posterior margin of the shell; the hinge consists of a few teeth situated along the hinder margin; muscular impression single, situated near the middle of the inferior margin, pallial line entire.

The three genera included in the present family are—

1. *Eurydesma*, Morris, 1845, (Strzelecki, New South Wales, &c., p. 275, and Dana in Geol. of Expl. Exped., p. 699). Shell oval or roundly cordate, rather thin, but very much thickened near the beaks, concentrically striated or nearly smooth; beaks strongly incurved with a sort of an excavated and gaping lunette in front; ligament large, occupying the greater part of the posterior, more or less straight hinge area, which is broad and extends below the beaks so as to make the ligament almost internal, one large, sub-conical cardinal tooth in the right valve somewhat curved upwards and corresponding to a pit in the left; several small muscular impressions near the hinge, but no other larger ones perceptible, neither has the pallial impression been as yet traced out; type, *E. cordata*, Sow. sp., from the New South Wales palæozoic rocks.

Morris suggests that this very remarkable shell should be placed near *Avicula*, but the general form, the excavated and gaping lunula, the strong development of the ligament below the beak, and the presence of a strong cardinal tooth in the right valve all tend towards a relation of the genus to *Tridacna* and *Hippopus*, from which it differs by the want of external ornamentation. The relations to *Hippopus* have been already alluded to by Dana.

2. *Tridacna*, daCosta, 1776,* (Elements of Conch., pp. 274 and 298, pl. vii, figs. 4-5). Pedal opening of the shell wide, hinge in the right valve with one short cardinal tooth posterior to the beak and two remote lateral, in the left valve with two small cardinal and one prominent lamelliform posterior lateral tooth; ligament below the beaks thickened, and often lodged in a special spoon-shaped excavation. DaCosta, I find, was the first to use the name *Tridacna* for our shells in a strictly generic sense, giving an excellent figure of what appears to be *T. Cumingii* or *compressa*.

* Klein used for some species of *Tridacna* the generic name *Chamatrachæa*, and it is believed that his figure represents a *Tridacna*; but as the figure as well as his characteristics are rather vague, the name has not come into use at all, and it seems of no advantage to introduce it now.

3. *Hippopus*, Meusch., 1787.* Shell quite similar to *Tridacna*, but the surface is more tubercular, and the pedal opening is only indicated by a number of small serrations of the margin.

H. and A. Adams state that the hinge is composed of "two compressed, unequal, primary teeth in each valve." There is, however, strictly speaking, no difference in the hinge of *Hippopus* and *Tridacna*. In the former we have in the right valve a rather long lamelliform cardinal tooth, the hinder part of which continues as a raised inner edge of the hinge-margin and is sometimes broken up into two or three lamellæ; besides this long cardinal tooth there are two posterior but rather indistinct lateral teeth; in the left valve the hinge-teeth are also very similar to those of *Tridacna*, except that the furrow separating the two cardinal teeth is continued posteriorly, and passes directly in the groove which bounds the posterior lateral tooth below.

With the exception of the peculiar palæozoic *Eurydesma* we do not know any fossil species of the *TRIDACNIDÆ*. Looking at the few recent forms, the character of the animals with their united siphons and the solid shells with the peculiar single cardinal tooth, fitting into a groove of the other valve, certainly indicate a relation to the *CHAMIDÆ*. The position of the median large muscular impression in the two recent genera is quite peculiar, but I think that the two smaller impressions below the anterior and posterior terminations of the hinge-area are to be more correctly identified with the two muscular scars of other Pelecypoda, though that opinion has been contradicted by several conchologists. There can be, however, no doubt that they serve for the attachment of similar muscles as in other Pelecypoda.

XX. Family,—*CHAMIDÆ*.

The animals of the recent *CHAMIDÆ* have the inner mantle margins united, the outer thickened, fringed and separated in their entire length; there is a small opening in front for the protrusion of a rather short, cylindrical, and usually angularly bent foot, and another opening behind for the two siphons which are separated, with fringed orifices, but very short; the labial palps are small, nearly quadrangular and obliquely truncated; one pair of gills on each side, unequal, narrow, the outer half posteriorly prolonged and united.

The shells are very solid, free, or with one valve partially attached to other shells, rocks, or corals; the beaks spiral and more or less marginal, muscular impressions two, large, pallial sinus entire; hinge usually with one blunt cardinal tooth in one valve, fitting between two more or less unequal teeth of the other valve; sometimes there is besides a small posterior lateral tooth present; ligament external, linear, generally situated in a groove running from the beaks to the hinge,

* Meuschen must be quoted as the authority of the genus, for as all the other forms (but *H. equinus*), noticed by Meuschen under the above name, have been placed by Lamarck in different genera, it must be understood that he reserved the name for that single species. DaCosta already figures it as distinct from *Tridacna*, but calls it a peculiar *Cockle*.

a portion of the ligament is often internal; the presence of a cartilage seems in some forms to be also indicated.

The solidity of the shells, spiral beaks, large muscular impressions, and the presence of one or two very strong cardinal hinge-teeth are the prominent characteristics of this family. Considering these, I think the family must receive a larger extension, than is usually given to it in conchological works. *Dicerocardium*, *Lycodus* and *Diceras* should certainly be classed together with the *Chamæ*. The first is a triassic form, the second probably liasic, the third jurassic and cretaceous.

In this last formation several other new forms appear, which in all the principal characters agree with *Chamæ*, as was some years ago pointed out by S. P. Woodward (Man. of Moll., 2nd ed., p. 37), whose classification I will in the main follow. The genera to which I allude are *Monopleura*, *Requienia*, *Caprina*, *Caprinula*, &c., &c., some of which are said to possess also an internal ligament, and if this be really the case those forms will have to be placed in the family *CHAMOSTREIDÆ*, the relation of which to the present family will be pointed out further on. The *HIPPURITIDÆ* (as restricted) will also form a distinct family from the present one, in which I will include all the forms with one valve spiral and the other more or less flattened and with concentric striæ of growth.

The shells of the recent and fossil *Chamæ* consist, as noted by Woodward, H. and A. Adams, and others, of three distinct layers; 1st, the outer, which is secreted by the external, free, and thickened portions of the mantle; it has a tubular structure and is deposited in separate layers, both these circumstances producing a peculiar reticulated appearance, so well known and formerly believed to be entirely peculiar to the shells of *Hippurites*. In the *Chamæ* the tubular structure is well seen in semi-decomposed shells, but the reticulated structure is very fine and in recent shells only traceable on a microscopical section. All the external ornamentation, with the spines, lamellæ, &c., and in fact the greater part of the thickness of the shell, is exactly as in *Hippurites*. I shall speak of this outer layer as the *reticulated* one.

2nd.—The middle layer is semi-transparent, opaque, of a silky appearance, and consists of vertical, prismatic cells. It varies in thickness in different species, and is sometimes very thin; it is only secreted within the extent of the pallial impression. I will call this the *prismatic* layer.

3rd.—The innermost is the thinnest layer, of a pearly or glassy appearance, milky or semi-transparent, and rather homogenous; this is the *glassy* layer; it appears to become obsolete or is not preserved in most fossil species.

In some tertiary species, as, for instance, *Ch. gryphina*, Lam., these layers can very well be traced. In a comparison of the recent *Chamæ* with the fossil *Caprotinæ* and *Hippurites* the distinctions of these three layers will be of very great importance, as I shall notice further on.

The recent *Chamæ* chiefly include tropical forms; they are, strictly speaking, littoral shells, living attached to corals and rocks, and many of them are out of water during low tides. Reeve describes 55 species in his Monograph, and but

few have been made known since. I am acquainted with at least two new species, one from the Andamans and the other from Singapore, but very likely several others will be found in our seas.

The genera arrange themselves according to their geological age as follows:—

1. *Dicerocardium*, Stopp., 1865, (Pal. Lomb., 3^{me} ser., Appendix p. 248). Shell, as far as known, equivalve, with strongly prominent and spirally twisted and carinated beaks without any perceptible place of attachment, solid and usually of large size; a free projecting lamina extends from the beaks to the hinge, which is provided in the left valve with a strong cardinal tooth corresponding to a pit in the right valve, and besides this there are two elongated laminar teeth in each valve adjoining or superseding the former; ligament external, situated in a groove along the upper and part of the posterior edge; the shell consists of an outer lamellated and inner fibrous layer; type, *D. Jani*, Stopp.

This genus is as yet only known from a few species represented in the so-called Infra-lias or upper triassic beds of the southern declivities of the Alps. I have described from the same geological horizon in the Himalayas a new species, *D. Himalayense*, (Mém. Geol. Survey of India, vol. v, p. 63).

2. *Diceras*, Lamck., 1804. Shell sub-equivalve, solid, with strong prominent, spirally incurved umbones, one of which is sometimes attached; a more or less distinct internal ridge runs internally from the umbones near the posterior margin of the shell and bounds the posterior muscular impression in front; left valve with a strong sub-anterior blunt cardinal tooth fitting into a fosset of the right valve which has posteriorly a very strong broad cardinal tooth; besides that there is in each valve a small posterior lateral tooth adjoining the muscular impression; this last is elongated, the anterior one more transversally (or longitudinally) oval; pallial line entire; ligament external, situated in a slight groove beginning at the umbones and extending along the posterior margin as far as the lateral tooth; it is supported by strongly thickened fulcra. Type, *Diceras arietinum*, Lam.

The species are not numerous in the upper jurassic and become rather rare already in the cretaceous deposits, but there appears to be a considerable difficulty in distinguishing from them some of the species belonging to the next allied genera, particularly when the fossil forms are not well preserved.

3. *Requienia*, Matheron, 1842, (Cat. Meth. et Descript. des corps org. foss. du Dept. des B. du Rhone, &c., p. 102). Shell inequivalve, lower valve large, spiral, contorted and adherent, upper valve smaller, more or less flattened, but always with a spiral beak; an internal posterior rib is usually seen in the lower valve from the umbo extending to the postero-inferior margin and bounding near it the posterior muscular impression; the hinge consists in the lower valve of a more or less prominent marginal, lamelliform tooth, fitting into a cavity of the smaller valve which has one tooth on either side (above and below) of it; there is besides a posterior small lateral tooth in each valve present; pallial line entire; ligament external, situated in an umbonal groove of the lower valve and extending to the hinge, and then along its postero-superior margin. Type, *R. ammonia*, Goldf. The hinge of this genus most

resembles *Monopleura*, differing from it by the superposition of the teeth in the upper valve, but the form of the shell is intermediate between *Diceras* and *Chama*. The structure of the shell is the same as in the former, the reticulated (outer) layer being laminar, the prismatic (one or two) which is somewhat thinner usually changed into crystalline limestone. The species of *Requienia* are as yet known only from cretaceous strata.

4. *Monopleura*, Math., 1842, (ibidem, p. 105). Shell inequivalve; lower valve larger, sub-spiral, sometimes conical, with the termination attached, upper valve smaller, more or less depressed, sometimes almost flattened like an operculum, but always with a marginal sub-spiral beak; lower valve usually with two internal more or less prominent ribs, one median, the other sub-posterior; hinge of the lower valve consisting of a single sigmoid elongated tooth, and two shorter teeth in the upper or flatter valve; these teeth are anterior and posterior, not upper and lower as in *Requienia*; sometimes there is a small posterior approximate lateral tooth present in either valve; muscular impressions two, elongated, pallial line entire; ligament external situated in an umbonal groove in the lower valve and extending to the hinge, where it is attached to the inner side of a slightly projecting hinge margin of the smaller valve. Type, *M. Valangiensis*, Pict. and Camp.

In form and sometimes also in ornamentation the *Monopleuræ* greatly resemble *Requeniæ*, but the hinge line is thicker, and the teeth in the upper valve are placed one behind the other, while in *Requienia* they are one above the other, the result being apparently obtained by the valves being considerably more spirally twisted. Only cretaceous species of *Monopleura* are as yet known.

5. *Lycodus*, Schafhæutl, 1863, (Süd-Bayerns, Leth. geog., p. 375). Shell inequivalve, oblong, moderately tumid, with large incurved and rather approached beaks, of solid structure, and concentrically costated on the surface. In the place of the hinge there seems to be in the left valve a large hinge-plate, the anterior portion of which is partially elevated and prolonged into a transverse tooth, and the posterior depressed, probably for the reception of the tooth of the other valve. From the posterior part a rib runs internally up to the umbones, and there is also a posterior elongated tooth present almost parallel to the margin of the shell.

One species, *L. cor*, is figured and described from an Alpine limestone bed of the Watzmann; the formation is not stated in detail, but it is probably lower secondary. It is difficult to form a correct idea of this fossil, as the hinge is as yet far from sufficiently known, but it seems to indicate a new form of the *CHAMIDÆ*, allied to *Chama* in external appearance, and to *Caprina* in the hinge. Single valves have a considerable resemblance to those of *Pachyrisma*.

6. *Chama*, Linn., 1758. Shell inequivalve, attached by one or the other valve, the free valve being, as a rule, the smaller one; surface usually richly ornamented with lamellæ and spines; hinge of the attached valve consisting of a deep curved furrow bounded above by a small ridge and below by a strong tooth, free valve with a single large corrugated sometimes flexuous cardinal tooth; a small posterior lateral tooth is usually present, situated close to the cardinal; muscular

impressions large, elongated, pallial line entire, somewhat truncate posterior; ligament situated in a deep groove of the attached valve along the supero-posterior margin, supported by a more or less thickened fulcrum and in the free valve attached internally to the somewhat projecting margin. Type, *Ch. frondosa*, Brod.

The sub-generic distinctness of *Arcinella* appears to be unsupported in the structure of recent and fossil *Chamæ*. The single cardinal tooth in the free valve readily distinguished *Chama* from *Monopleura*. We have no distinct account of any species of true *Chama* occurring in the jurassic period, and even in the cretaceous, there are only few species known with sufficient certainty, others more resemble in form *Diceras* and *Requienia*. In tertiary deposits several typical forms occur.

7. *Caprina*, d'Orb., 1823, (*Plagioptychus*, Math., 1842; vide Pal. Franç. crét., vol. iv, p. 179; Zittel in Denksch. Akad. Wien, 1866, vol. xxv, pt. ii, p. 152). Shell inequivalve, both valves with distinctly twisted, sub-spiral beaks, the lower and generally larger valve is always attached when young, in full grown specimens the place of attachment sometimes becomes more or less obsolete; the hinge of the attached valve consists of a more or less projecting and elongated sigmoid cardinal tooth with a large pit in front of it and a small marginal one behind, in which the corresponding two teeth of the free valve fit in; the anterior muscular impressions are on more or less elevated and rough prominences, the posterior are larger, on a shallow excavated plate; pallial line simple; ligament external, situated in a groove running in each valve from the beaks to the hinge-margin and extending here along its edge.

The shell consists at least of two distinct layers, the outer chiefly striated, being very thick and often very porous, the inner (pyramidal) is more solid, and in large specimens forms the interior laminae between the chambers of the attached valve. The free valve is said to be covered with an outermost, thin brown layer; this is probably the thickened epidermis which is thrown off in the lower valve on account of the usual more lamellar structure. It does not appear to be a special layer, but the outer surface of the striated one is only more solidified. There are also internally some ribs occasionally present, and these are very variable; sometimes there is only one posterior, in other specimens an additional median one appears.

Type, *Cap. Anguilloni*, d'Orb. Only few species of *Caprina* are known from cretaceous rocks.

Woodward (Manual, p. 450,) states that there is an internal cartilage present, but there do not seem to be anywhere internally special grooves for it, and he probably only alludes to the extension of the ligament along the inner edge of the hinge line; for in most of the recent *Chamæ* the ligament is also to a certain extent internal. The characters of the genus were ably described by Zittel in Denksch. Akad. Wien, vol. xxv, pt. 2, p. 152, &c.

8. *Caprotina*, d'Orb., 1842, (Pal. franç. terr. crét., iv, p. 236). Shell inequivalve, the attached valve is the larger, often radiately striated, while the upper is less distinctly so or not at all; the latter is usually moderately convex with a marginal spiral beak; hinge in the lower valve with a median cardinal tooth and a pit on

either side into which the two cardinal teeth of the upper valve fit; one or more ridges are usually seen in the interior of the valves extending from the umbones to near the periphery; muscular impressions on more or less projecting rugose ridges, generally at the base connected with the hinge-teeth; pallial line simple; ligament situated in a narrow groove extending from the umbo of the lower valve to the hinge; in the upper valve this groove is less distinct and appears to be sometimes obsolete. Woodward states that the uneven ridges on either side of the ligamental groove support an internal cartilage. This may be the case, and certainly when looking on a cast, as that of *C. quadripartita*, it appears to be very probable, but if we judge from analogy, these rough or ribbed parts appear to be the same which in *Sphærulites* and *Radiolites* are said to support the retractile muscles of the valves. Should, however, Woodward's explanation prove to be correct, this and the few following genera will have probably to be associated with the *CHAMOSTREIDÆ*, as already noticed. But I am not sure whether all these fossil genera are really sufficiently distinct. Good materials may necessitate considerable reductions in their number.

The hinge of *Caprotina* is almost quite the same as that of *Monopleura*, with the only exception that the muscular impressions are on strongly raised prominences and the hinge-teeth themselves much stronger in the former genus. Pictet and Campiche in their last reviews of this family have restricted the name *Caprotina* to a few species only, namely, such forms as have the lower valve slightly spiral, with a broad place of attachment, the upper valve somewhat convex and with a marginal pointed and sub-spiral umbo, and no sulci on the external surface of the shell. As compared with *Caprina*, the present genus only differs from it by the more equal form of the two cardinal teeth in the free valve.

9. *Diplidia*, Math., 1842, (Cat. Meth., &c., p. 111). Shell inequivalve, solid, concentrically lamellated and finely radiately striated; attached valve conical, elongated with a single longitudinal furrow on one side; free valve slightly convex, with an eccentric, sub-marginal, pointed umbo and a groove from it running to the margin and corresponding with that of the other valve; hinge not known; type, *D. unisulcata*, Math., from upper cretaceous beds at Martiques. Pictet and Campiche (Pal. Suisse, 5^{me} ser., 4^{me} part., p. 34,) suggest that until there is something more definite known of Matheron's type species of *Diplidia*, the genus should be retained as characterized by its author. D'Orbigny placed it in *Caprotina*, but had not seen a specimen of the species. There can be no doubt that the peculiar conical and obtusely pointed lower valve offers some distinction from *Caprotina*, and entirely resembles that of a *Sphærulites*. But from this the genus again differs by the form of the free valve. The want of any external dorsal sulci separate it from *Monopleura*, and thus it seems best to retain provisionally the genus as originally defined.

The same applies to the two next genera, both of which are as yet little known, and have been referred by Woodward, on the suggestion of Sharpe, to a single genus; but it appears preferable to keep them provisionally distinct. Both have most likely to be referred to the *CHAMOSTREIDÆ*, especially if the so-called ligamental

furrow should prove that it has no connexion with the ligament, but is caused by the hinge-rib.

10. *Caprinula*, d'Orbigny, 1847, (Pal. franç. terr. cret., iv, p. 187). Shell inequivalve, both valves large, cellular, with internal tubuli; lower or left valve larger, elongated, sub-spiral, with a longitudinal ligamental furrow, at the base of which where it enters the margin of the shell there exist a number of rather larger pits into which the ligament apparently extends, producing an internal cartilage; in front of these so-called cartilage-pits there is a strong cardinal tooth extending down the interior wall of the valve, and there are said to be two cardinal teeth in the free, upper valve, which is smaller and distinctly spiral with an incurved beak. Type, *C. Boissyi*, d'Orb.

11. *Caprinella*, d'Orb., 1847, (l. cit., p. 189). Shell inequivalve, attached valve larger, involute, spiral with a ligamental furrow on the convex side, and apparently with numerous cartilage-pits internally, the convex side of the shell being very thick and fibrous, internal part chambered; free valve smaller, sub-conic, elevated, with an eccentric pointed slightly twisted umbo. Type, *C. triangularis*, Desm.

LIST OF CRETACEOUS SPECIES.

These have lately been catalogued by Pictet and Campiche in Pal. Suisse 5^{me} ser., 4^{me} part., 1868, p. 4 et seq., where the respective references to the various species will be found; I shall have to add but few which have not been included in that list.

- 1.—*Diceras Germani* and *Lorioli*, Pict. and Camp.
- 2.—*D. gaultinum*, Pict. and Roux, is, on account of the inequality of the valves, more probably a *Chama*, as Pictet and Campiche also suggest.
- 3.—*Diceras arietina*, d'Arch., (non Deluc.), from cretaceous rocks, is supposed to be a *Caprina*.
- 4.—*D. Favri*, Sharpe, is most likely a *Requienia*, but distinct from *R. Lonsdalii*.
(*Diceras guttata*, Sharpe apud Gabb, is *Dianchora? guttata*, Sharpe, and does not belong to the present family).

5.—*Requienia Jaccardi* and *eurystoma*, Pict. and Camp.

6-10.—*R. Lonsdalii*, Sow., sp., *ammonia*, Goldf., sp., *gryphoides*, Math., *lamellosa*, d'Orb. *Grasiana*, Mortillet.

11-22.—*R. rugosa*, *navis*, *Delarucana*, *ornata*, *laevigata*, *Curentonensis*, *carinata*, *Toucasiana*, *Archiaciana*, *sub-æqualis*, *Michelini*, and *Marticensis*, are described by d'Orbigny.

23.—*Req. Cyphyana*, Ryck., is quoted by Bosquet from the upper cretaceous beds of Bergen (vide Staring's Bodem van Nederland, ii deel).

24.—*Req. Lithuana*, Eichw., (Leth. ross., livr. x, p. 362,) was originally described as *Acardo*; it differs from both, *Requienia* and *Caprotina*, by its short straight beaks, and very likely does not belong to this family.

25. *Req. texana*, Römer. Meek retains this species in *Caprotina*, originally described by Römer under that generic name, but it appears more likely to be a *Requienia*.

26-28.—*Monopleura corniculum*, *Valangiensis*, and *Valdensis*, Pict. and Camp.

29-36.—*M. varians*, Math., *Michailensis*, Pict. and Camp., *depressa*, Math., *trilobata*, d'Orb. sp., *imbricata*, *sulcata* and *Marticensis*, Math., *Plauensis*, Geinitz, sp.

37.—*M. texana*, Römer, has been transferred by Gabb to *Caprotina*, as *Cap. Römeri*, and by Pictet and Campiche to *Requienia*. The species could belong to either of the genera, but viewing it externally it does not appear to differ in the least from *Chamostrea*.

38.—*M. subtriquetra*, Römer, from Texas may, as far as the fragmentary valve figured by Römer is concerned, belong to either *Monopleura* or *Requienia*, but until more is known of the species Römer's original determination may best be retained.

39-43.—*Chama triedra* and *gracilicornis*, Pict. and Camp., *Ch. cretacea*, *cornucopiæ*, and *angulosa*, d'Orb.

44-48.—*Ch. spondyloides*, Bayle, *costata* and *semi-plana*, Römer, *Moritzi*, Stromb., *supra-cretacea*, d'Orb.

49.—*Ch. sub-orbiculata*, d'Orb., is a doubtful species.

50.—*Ch. Münsteri* was described by Hagenow as *Exogyra*, and is doubtfully placed in this genus by Bosquet, though it probably belongs to it.

51-52.—*Ch. Haueri* and *detrita* are described from the Gosau by Zittel (Denksch. Akad., Wien, vol. xxiv, pt. ii, p. 147).

53-54.—*Caprina adversa* and *Aquilloni*, d'Orb. Zittel (Denksch. Akad., Wien, xxv, pt. ii, p. 154,) unites, I think very properly, d'Orbigny's *C. Coquandiana* and Reuss's *C. exogyra* with *C. Aquilloni*.

55.—*C. laminea*, Gein.

Caprina ? rotundata, Schafhäutl, (Bayerns Leth. Geog., p. 377,) is based upon an *Exogyra*-like fragment of a shell, thoroughly insufficient for specific or even generic determination.

56-57.—*C. Baylei* and *Verneuilli* (Bayle) are described by Coquand in his Monog. de l'Étage Aptien de l'Espagne, p. 156, &c.

58.—*C. Matheroni*, Coq., is from Algiers.

59-63.—*C. crassifibra* and *Cuadeloupæ* of Römer, and *C. occidentalis*, *planata*, and *quadrata* of Conrad, are noted from North America.

64-67.—*Caprotina quadripartita*, *costata*, *striata*, *semistriata*, and *Cenomanensis* are described by d'Orbigny.

68.—*Caprotina costullata*, Müller, Suppl. Mon. Petref. Aachen Kreidef., p. 16. Bosquet places it with a query in *Chama*, (see Staring's Bodem van Nederland, ii deel).

69.—*Cap. Lazzykowi*, Eichw., Leth. ross., livr. x, p. 359. The figure appears to represent a lower valve (l. cit., pl. 18, fig. 32), showing only a single pit below the beak, and in that case the shell would not seem to differ generically from *Chama*.

70.—*C. caucasica*, Eichw., l. cit., p. 360.

71.—*C. russiensis*, d'Orb., Eichw., l. cit., p. 360; the upper valve resembles that of *C. Cenomanensis*, but the lower is conical, more like that of a *Monopleura* than of a *Caprotina*.

72.—*Caprotina ? Senseni*, Con., sp., is from North America.

73.—*Diplidia unisulcata*, Math.

74-77.—*Caprinula Boissyi*, d'Orb., *Caprinula brevis* and *d'Orbignyi*, Sharpe, *Caprinula Neapolitana*, Meneghini.

78-80.—*Caprinella Doublieri*, d'Orb., *C. triangularis*, Desm., sp., *C. depressa*, d'Arch.

81-84.—*C. coralloides*, Hall and Meek, *cornuta*, *loricata*, and *quadrangularis* of Tuomey are noted in Meek's Check-list of North American cretaceous fossils under the name of *Ichtyosarcolithus*.

85.—In the South Indian cretaceous rocks the present family has as yet only been found represented by two species, *Chama deplanata*, n. sp., and a single upper valve appears to be identical with that of *Caprotina Cenomanensis*, d'Orb.

CHAMA, *Linné*, 1758, (vide p. 230).

✓ CHAMA DEPLANATA, *Stoliczka*, Pl. XXII, Fig. 5.

Chama testa ovata, multo altiore quam longa, valde depressa; valva inferiore omnino adnata, plana, ad marginem superiorem paulo elevata ac lamellosa; valva superiore sinistrorsa, paululum convexiuscula, in superficie dense spinulose lamellata, spinis sub-æqualibus in seriebus costuliformibus radiantibus dispositis, apice acuto, lateraliter incurvo instructa.

Height of shell : its length 1.31

The single specimen of this remarkable species is distinguished by its very depressed and high form in proportion to the length of the shell. The lower valve is attached in its entire extent, only the upper margin is somewhat raised and slightly incurved towards the upper valve, which is finely spinulose and radiately costulated all over, the beak being lateral, pointed, and incurved. The ornamentation quite agrees with that of many recent species of *Chama*.

Locality.—Anapaudy, in a brownish calcareous sandstone; apparently very rare.

Formation.—Trichinopoly group.

✓ CAPROTINA CONF. CENOMANENSIS, *d'Orb.*, Pl. XXII, Fig. 2.

A single upper valve was found in a conglomerate east of Kaudoor; its rounded form, moderate convexity, sub-terminal incurved apex, and numerous sub-equal rather sharp radiating ribs do not show any essential difference from those of the upper valve of *Caprotina Cenomanensis* (*Requienia idem*, *d'Orbigny*, Pal. franç. terr. cret., vol. iv, p. 261, pl. 595, figs. 1-4).

The ribs in the Indian specimen are probably a little sharper, but this may be owing to the weathering off on the surface. Until more and better preserved specimens have been found, it appears safest not to introduce a new specific denomination.

The two hinge-teeth are distinctly visible in the valve, the posterior tooth is slightly larger, and an oblique rib runs from it almost parallel to the margin; it is probably the one which is required for the attachment of the posterior muscle.

Locality.—Kaudoor.

Formation.—Arriallor group.

XXI. Family,—CHAMOSTREIDÆ.

The animal of the single genus and species belonging to this family, *Ch. albida*, Lamarck, has the mantle margins perfectly united with a narrow opening for the foot, which is rather small and somewhat compressed, almost rudimentary as in *Chama*; the two siphons are very short with fringed orifices, the palpi are long and obtusely pointed; the gills are stated to be single, but the lateral groove showing the unequal portions of the leaves is distinctly seen in Hancock's figure.

Shell solid, attached by a portion of one valve, two large muscular impressions, pallial line simple, a shelly ossicle attached to the valves by a cartilage close to or behind the hinge.

Chamostrea, Roissy, 1805. Lower valve attached on one side only, convex, with the beak incurved, upper valve smaller, flattened; shell inside slightly perlaceous; hinge in the upper valve with a single tubercular tooth fitting into a pit of the lower valve; behind the tooth lies the ossicle, the cartilage being situated in small pits in each valve.

Comparing the animal and shell of *Ch. albida* with that of *Chama* their relation is indeed striking, especially when we select such species as the fossil *Chama gryphina*, Lam., which externally is entirely indistinguishable from *Chamostrea*. The situation and size of the muscular impressions are also very similar, except that in the latter the posterior scar is far removed from the hinge, while in *Chama* it lies always close to it; the hinge-teeth of *Chama* are, of course, constantly different; they always want the cartilage and ossicle, but the narrow and very thin almost linear ligament well agrees in some species of *Chama* with that of *Chamostrea*; however, as the animals of the former in the character of the mantle margins and of the siphons also present considerable differences from those of the latter, the separation of the two families must be kept up.

The *CHAMOSTREIDÆ* form in many respects a transition from the *CHAMIDÆ* to the *HIPPURITIDÆ*, particularly to some *Requienia* and others, which as to external form and the flat upper valve appear very closely allied to *Chamostrea*. The recent species has the outer surface of the shell lamellar and distinctly different from the inner, but it is not fibrous as in *Requienia*; the presence of the ossicle and the internal cartilage has, however, undoubtedly its true analogue in the structure of the hinge of such species of *Requienia Lonsdalei*, Sow., sp.

As for fossil species of *Chamostrea* we know as yet nothing, but it seems doubtful whether the recent *Chamæ* have been all properly examined as to their internal structure. The only character which would entitle us to refer a fossil species to *Chamostrea* is the presence of a corresponding groove or pit in both valves, for it is not very probable that the ossicle will often remain preserved. Such internal characters are, however, rarely traced out in fossil species.

XXII. Family,—*HIPPURITIDÆ*.

Nothing is known of the animals of this entirely extinct family as yet peculiar to the cretaceous period. We can only presume from the relation of their shells to some of those of *Monopleura* and *Caprotina*, and of these again to those of *Chama*, that the animals were somewhat allied to the latter; and there can be little doubt that such was really the case. But in several respects some of the *HIPPURITIDÆ* exhibit such peculiarities that at the first sight they hardly appear to have a relation to ordinary Pelecypoda. When the internal structure of their shells has been more carefully studied, we shall no doubt be better able to make somewhat more approximate comparisons between the present and the former family. As to thickness of the

mantle margins both families must have been very similarly organised. Woodward says, that *Hippurites* possesses a distinct pallial sinus. It is nothing extraordinary that any one should see in the posterior internal folds or flexures the indication of a pallial sinus, and, strictly speaking, there is nothing very much opposed to that explanation, except that we know nothing exactly similar to this to occur in other Pelecypoda. The shells consist of two very unequal and dissimilar valves, of which the attached one is the larger, more or less conical and sub-spiral; the upper is operculum-like, flat or slightly elevated with a central or sub-central apex and concentric striæ of growth; the hinge-teeth are variable, but apparently always more developed and more complicated in the free valve; there is no distinct trace of a ligament. The outer reticulated layer of the shell is mostly developed in all *Hippuritidæ*; the inner layer is usually thin, sometimes hardly traceable.

All the species as yet known are from cretaceous deposits, with the exception of the peculiar *Tamiosoma* which is from the tertiary Californian deposits, and is as yet only doubtfully referred to the present family, (vide postea).

The cretaceous species have been sub-divided into the three following genera.

1. *Radiolites*, Lam., 1801, (vide Bayle in Bull. Soc. Geol., France, 2nd ser., xii, p. 793). Lower valve conical, attached near the umbo, very solid. The surface usually strongly lamellar, margins ribbed and widely expanded, internally often with two grooved longitudinal ridges into which the edges of a curved widely projecting cartilage-plate fit, but these grooved ridges themselves do not usually extend to the margin of the valve. The cartilage-plate is inserted near the centre of the free valve and extends far below and obliquely towards the base of the attached valve without, however, touching it except at the lateral edges which are often serrated. The size and extent of this cartilage-plate vary greatly in different specimens, and the ridges in the lower valve seem to become sometimes obsolete. The cartilage itself is apparently situated between this projecting, internally concave, striated plate and the attached valve; the muscular impressions are situated next to the cartilage-plate; in the lower they are large, but not particularly marked; in the upper smaller valve they are situated on solid prominences, these being more or less roughly striated; pallial line entire.

A peculiarity of the lower valve of *Radiolites* is its usually strongly lamellar surface, the thickness of the shell being penetrated by numerous branching canals; some specimens are on the surface also longitudinally ribbed, but this ornamentation more often occurs in *Sphærulites*. Another peculiarity of the same valve is the large longitudinal area which extends from the beak to the ventral side and is usually destitute of the lamellæ and ribs which occur on the rest of the surface. This area does not correspond to the hinge area of *Ostrea* or *Spondylus*, as it would appear to do at first sight, for the hinge is situated to the left, or inferior side of it; what organ or particular edge of the mantle has produced it I am unable to conjecture at present.

The smaller valve is rarely equally richly ornamented as the larger; it is most commonly smooth with fine concentric striæ of growth.

Types, *R. angulosa*, d'Orb., or *R. Mortoni*, Mant. In the first the internal ridges of the attached valve do not seem to be present, in the latter they are well developed, but do not reach to the margin. Bayle and others have referred this last species to *Sphærulites*, but this is, I believe, a mistake. I also think that several other species, as *Rad. Pailletteana* and *Martiniana* of d'Orbigny, rather belong to this genus than to *Sphærulites*, to which they had been referred by Bayle.

2. *Sphærulites*, de la Merth., 1805, (Bayle, *ibid.*, p. 800). Attached valve generally elongately conical with longitudinal more or less foliated surface and the margins radiately ribbed, internally with a single umbonal rib extending the whole length of the valve. Free valve smaller, similar in form and structure to that of *Radiolites*, but with a median tooth or columella corresponding to the hinge-rib of the other valve, in which there is on each side of the rib a cartilage-process, the two cartilage-plates being sometimes united in front, and next to them are situated the raised muscular scars. Type, *Sphærulites angeiodes*, Picot de la Peir.

The presence of a hinge-rib readily distinguishes the present genus from the former, and the absence of any other ribs or folds in the attached valve separate it from *Hippurites*. In several tolerably well preserved specimens of the lower valve I have not been able to trace the extent of the muscular impressions, but from some valves figured by d'Orbigny they seem to be very large. In the upper valves I have seen no special hinge-teeth or lamellæ, but whether they do not exist in some species, as has been recorded, I am unable to say.

3. *Hippurites*, Lamck., 1801. Lower valve large, more or less distinctly conical, attached at the end, generally longitudinally sulcated on the surface, base internally chambered; hinge consisting of a single hinge-rib or column, with a more or less shallow cartilage pit on either side, anterior muscular scar large, sub-marginal, often situated on a projecting plate, posterior next to the hinder cartilage-pit, followed by two usually unequal projecting ribs or duplicatures of the shell. Smaller valve opercule-like, flat or slightly elevated, with a central apex and often variously punctated and porous; internally with two strong slightly diverging hinge-teeth; the anterior muscular impression is situated on the side of a strong tooth-like vertical projection and is usually divided into portions.

Woodward explains the last duplicature of the lower valve as corresponding with the pallial sinus of other Pelecypoda. In a fine lower valve of *H. radiosa*, for which we are indebted to the kindness of Prof. Hebert, there is a pit supported by a column extending the entire length on each side of the hinge-rib, and a somewhat internally projecting lamina extends from the median duplicature to beyond the posterior one. Either this lamina was produced by an extension of the posterior muscular impression or it really indicates a pallial sinus; it is scarcely possible to find another explanation for it.

Woodward suggested two sub-genera of *Hippurites*, which latter name he restricts to the typical species, such as *H. cornu-vaccinum*, Bronn, or *H. Loftusi*, Wd., these having the hinge-rib well developed.

For some species of which he calls *H. bioculata*, d'Orb., the type, he proposed the name *Dorbignia*, (? *Orbignia*), and a third group of which *H. monilifera* from Jamaica is the type he calls *Barrettia* (vide Geologist, 1862, p. 375). *Dorbignia* is said to have the hinge-rib obsolete, but this appears to be the case only in some specimens in which it becomes obsolete near the peristome of the shell. Such is also often the case in *Sphærulites* and *Radiolites*. In *Barrettia* the hinge-rib also becomes obsolete near the aperture, but exists below in the interior of the lower valve, and the outer layer of the shell is reduced to numerous narrow columns of different length, entirely cemented by the inner layer of the shell, which besides occupies the whole interior of the valve. I have not seen either *H. bioculata* or *monilifera*, but the character referring to the sooner or later disappearance of the hinge-rib near the peristome, pointed out, seems to me to be of little importance, and I have great doubt that it can be used even in a sub-generic sense. The structure and thickness of the various species of *Hippurites* vary enormously, and the way in which a shell has been preserved often alters a good deal its aspect.

Zittel in his admirable Monograph* of the Gosau *Rudistæ* suggests that two more sections can be distinguished, one represented by *H. organisans* and the other by *H. dilatata*. The first has the outer shell layer not much developed, but still more than *H. moniliferus* and most other *Hippurites* which are not strongly ribbed. *H. dilatata* has the anterior muscular impression situated on a laminar projection, a character which also appears to be common to many other species of *Hippurites*. Parts of it are distinctly preserved in our specimen of *Hipp. radiosa*, Desm.

4. *Tamiosoma*, Conrad, 1856. The type of this genus is a very peculiar fossil from the upper miocene deposits of California, *T. gregaria*, Con. Gabb in the 2nd volume of the Palæontology of California (pp. 61-63) has very ably discussed the organization of this fossil, and comes to the conclusion that it is most likely a species of the *HIPPURITIDÆ*. The specimens which have up to the present been found resemble the elongated, lower valves of *Hippurites* with a small place of attachment apparently at the thinner or lower end. They are sub-cylindrical with rather thick walls consisting of two or three layers, possessing the same reticulated and striated structure as that of *Radiolites*, and others. The lower portion of the shell is composed of a large number of irregular chambers or septa which are produced by lateral prolongations of the inner wall. The end is occupied by a large cavity, similar to the 'body-chamber' of *Hippurites*, but no impressions of teeth have as yet been observed in it. The outer surface is longitudinally striated in the type species which grows in clusters, as does, for instance, *H. organisans*, Defr.

When I first saw Conrad's description and figure of this species the irregularity of the chambers or septa gave me the impression that the fossil might be a coral, but the more detailed description of Gabb, though it does not altogether remove that impression,—certainly points out affinities which are very much in

* Denk. Akad., Wien, vol. xxv, pt. 2, p. 135.

favour of his classification of this problematic fossil. The upper valve, says Gabb, has not yet been observed.

In some respects *Tamiosoma* recalls the organisation of the peculiar *Hippurite* from Jamaica, called by Woodward *Barrettia*.

LIST OF SPECIES OF *HIPPURITIDÆ*.

Lists of most of the species of this family have been lately published by Pictet and Campiche in the "Mat. p. l. Pal. Suisse", 5^{me} ser., 4^{me} partie, p. 40, &c. The generic and most of the specific identifications have been accepted according to the elaborate papers of Mr. Bayle, published in the Bull. Soc. Geol. de France. I shall here only quote the names of the species, adding a few which are not included in that last comprehensive list. With reference to the generic determinations of some of the species of *Radiolites* and *Sphærolites* I have already expressed some doubt, and I shall note them in detail further on, though for the present these notes can only be accepted as suggestions, as I have no sufficient materials for comparison. But it seems to me that the discrimination of the two last named genera has not been fully carried out, and that the occasional presence of the so-called cartilage hinge-ribs in the attached valve of *Radiolites* has given rise to pronouncing the species to belong to *Sphærolites*, when only one of those ribs was observable.

1-4.—*Radiolites canaliculata*, d'Orb., sp., *cornu-pastoris*, Desm., sp., *angulosa*, d'Orb., sp., *lumbricalis*, d'Orb., (the last is probably a *Sphærolites*).

5.—*Rad. acuticostata*, d'Orb. This is a very peculiar costate form, having the free valve also strongly ribbed and the apex sub-central; it possibly indicates a special section of *Radiolites*.

6-15.—*Rad. excavata*, d'Orb., *ingens*, Desm., sp., *fissicostata*, d'Orb., *Royana*, d'Orb., *Mauldei*, Coq., *crateriformis*, Desm., sp., *Jouanneti*, Desm., *Bournoni*, Desm., *undulata*, Gein., *Saxoniæ*, Röm., sp.

16-18.—*R. Trigeri*, Bayle, *Lapeyrousei*, Gold., (apparently as distinct from *radiosa*), and *Ciplyana*, Ryck., are quoted, besides some others by Bosquet from the Maastricht beds in Staring's Bodem van Nederland, ii deel.

19.—*Biradiolites Rozowii*, Fisch., is described by Eichwald in his Leth. Ross., 10^{me} livr., 1867, p. 357. It appears to be a *Radiolites*, though the existence of two furrows is mentioned in both valves. It was originally described by Fischer as *Cibicides Rozowii* from upper cretaceous beds at the river Ratowka near Vereya in Govt. Moscou.

Eichwald also mentions *Enargetes* of Fischer, which may be a *Radiolite*, and another problematic form which Fischer called *Tripodetes*.

20.—*Rad. Nicaisi*, Coq., is from Algiers.

21-25.—*Rad. Aimesii*, Tuom., *Austinensis*, Röm., *lamellosa* & *Ormondii*, Tuom., and *R. Tuomeyana*, Gabb, are quoted from North America in Meek's Check-list of cret. foss., Smith. Misc. Coll., No. 177, p. 5.

Sphærolites (vide Pict. and Camp., l. cit., p. 50).

26-45.—*Sph. Blumenbachii*, Stud., *Marticensis*, d'Orb., sp., *erratica*, Pict. et Camp., *paradoxa*, P. and C., *foliacea*, Lamck., *Fleuriansi*, d'Orb., sp., *triangularis*, d'Orb., sp., *polyconilites*, d'Orb., sp. (non *polyconites*), *subdilata*, *elliptica*, and *Germani*, Gein., sp., *falcata*, Reuss., *Mortoni*, Mant., (is to all appearance a *Radiolites*), *Ponsiana*, d'Arch., *Béaumonti*, Bayle, *radiosa*, d'Orb., sp., *Sauvagesi*, d'Hombres Fir., sp., *Nouleti*, Bayle, *squamosa*, d'Orb., *angeiodes*, Picot d. l. Peir.

46-48.—*Sph. Martini*, *Paillettei* and *sinuata* of d'Orbigny have in external appearance quite the form of *Radiolites*.

49.—*Sph. Desmoulinsiana*, Math., (*Moulinsi*, Bayle). Matheron's original figure would be much sooner taken as that of a *Radiolites* than that of a *Sphærolites*.

50-56.—*Sph. Hæninghausi*, Desm., *alata*, d'Orb., sp., *Coquandi* and *Sæmanni*, Bayle, *cylindracea*, Desm., sp., *Toucasiana*, d'Orb., sp., *expansus*, Duj; the last is quoted as a doubtful species.

57.—*Sph. Styriacus*, Zittel, (Denksch. Akad., Wien, vol. xxv, pt. ii, p. 151, pl. 26, figs. 5-7,) is from the Alpine Gosau deposits.

58.—*Sph. Faujasi*, Bayle, is quoted by Bosquet from Maastricht (Staring's *Bodem van Nederland*).

Hippurites (vide Pictet and Camp., l. cit., p. 58).

59-66.—*Hipp. cornu-vaccinum*, Bronn, *sulcata*, Defr., *organisans*, Montf., sp., *bioculata*, Lamek., *dilatata*, Defr., *Sarthacensis*, Coq., *radiosa*, Desm., *Lamarckii*, Bayle.

67.—*Hipp. Arnaudi*, Coq., from the Charente and from Algiers (Geol. and Pal. de la. Const., p. 224).

68.—*Hipp. Toucasiana*, d'Orb., is retained as a distinct species from *organisans* by Zittel (vide Denksch. Akad., Wien, vol. xxv, pt. ii, p. 140, pl. 23, figs. 1-6).

69.—*Hipp. exarata*, Zittel, ibidem, p. 144.

Pictet and Campiche (Pal. Suisse, l. cit., p. 60,) add a list of doubtful species: *H. Chilensis*, d'Orb., *H. Fortisi*, *turriculata*, *fistuloidea*, *nana*, *contorta*, *maxima*, *fasciata*, *rugulosa*, *turricula*, *dilatata*, *imbricata*, *Zoveti* of Catullo and *H. flexuosa* of Spada and Orsini.

70.—*Hippurites (Barrettia) monilifera*, Woodw., is from Jamaica (vide Geologist, v, p. 372).

71.—*H. Texana*, Römer.

72.—*H. Syriaca*, Con., from Palestine, is somewhat allied to *H. organisans*.

73-76.—*H. Loftusi*, *colliciatius*, *corrugatus*, and *vesiculosus* are noted by Woodward from Persia (Quart. Journ. Geol. Soc., Lond., vol. xi, pp. 58-59).

No species of *Hippurites* has as yet been found in our South Indian cretaceous deposits with the exception of a fragment from a highly silicious conglomerate of the Arriallor group. This fragment has an elongately oval section, with a shallow broad almost smooth area on one of the broader sides; by one narrower side it was attached to another specimen, and the rest of the surface is rather finely costulated, somewhat resembling the surface of *H. cornu-vaccinum*, Bronn. The base shows the beginning of the air-chambers, and the rest consists apparently of the body-chamber, but no internal ribs are traceable, and therefore the fragment may also have been derived from a *Sphærolite*.

77-78.—Of the two other cretaceous genera one species of each has been found, *Radiolites mutabilis*, n. sp., and *Sphærolites indica*, n. sp.

RADIOLITES, Lam., 1801, (see p. 237).

✓ *RADIOLITES MUTABILIS*, *Stoliczka*, Pl. XXI, Figs. 1-3; Pl. XXII, Fig. 3.

Rad. valva inferiori majori, sub-conica, plus minusve elongata, depressiuscula, apice adnata, transversaliter multi-lamellata, areâ lata sub-triangulari ab apice ad marginem aperturæ entensa, sub-excarvata, sub-lævigata, prope medium duabus costis bifidis longitudinalibus inæqualiter bipartita instructa, ad apicem concamerata; valva libera operculiformi, lævigata, striis incrementi concentricis notata, intus lamella cardinali, seu cartilaginigera, postice concava et oblique projiciente, ejusque marginibus costis duabus longitudinalibus furcatis in valva altera congruentibus, et ad utrumque latus laminæ cardinalis jugo muscolari elongato et rugoso instructa.

The form of the lower valve is as usually very variable, more or less elongated and conical, attached at the apex. The surface is strongly lamellated, the lamellæ being formed of the reticulated layer of the shell and traversed by various

anastomosing, but very thin canals; at the aperture these lamellæ form a large margin, being only interrupted by a broad bipartite, smooth area which runs from the apex to the margin. What the nature of this flattened or partially excavated area is, it is difficult to explain. It certainly must be caused by a peculiarity of the mantle margin, but it does not correspond to the hinge area of *Ostrea* or *Spondylus*. The hinge lies (see *h* in figs. 2 and 3 on pl. xxi) somewhat below to the left of this area, where the two bifid ribs are internally situated, in which the edges of the concave cartilage-plate of the upper valve fit. Next to the cartilage-plate in the free valve are the elevated, roughly striated muscular ridges. In figs. 3 and 3a on plate xxii the different parts are also noted in detail. The only probably correct suggestion regarding the presence of that bipartite excavated area is, that it may have been produced by the produced siphonal openings of the animal, for it is situated behind the posterior muscular impression.

Locality.—Comarapolliam, in a light grey conglomeratic sandstone; very common.

Formation.—Arriallor group.

SPHÆRULITES, *de la Merth*, 1805, (see p. 238).

✓ SPHÆRULITES INDICA, *Stoliczka*, Pl. XXI, Fig. 4, Pl. XXII, Fig. 4.

Sph. valva inferiori cylindraceo conica, elongata, moderate curvata, in superficie costis numerosis acutis multilamellosis quarum nonnullis (?) fortioribus ornata, intus costa unica longitudinali instructa apertura subrotundata, ad marginem undique expansa et radiatim costata.

This is a very solid, elongately conic, slightly curved form, gradually increasing in thickness. The surface is ornamented with longitudinal ribs, which are sharp and strongly lamellated. Some of the ribs appear to be stronger at one side, but none of the specimens examined is so far perfect as to show their number and relative size clearly. The aperture is roundish, with the margin largely expanded and radiately costulated. The inner layer of the shell is, as in *Radiolites*, thin, but shows only a single longitudinal so called hinge-rib. A tolerably perfect specimen, partially a cast, does not show any concameration towards the apex.

Together with three fragmentary specimens of the lower valve one upper valve was found; it is figured (fig. 4) on plate xxii. From its resemblance to that of other authentic *Sphærulites*, it is probable that it belongs to the present species, though no decisive proof can be given. The figure shows the internal side, the other side being so thoroughly cemented to the rock that it is impossible to detach it. This internal view shows the valve to be slightly excavated, of a roundish oblong form, with concentric undulating striæ of growth, shelving edges all round, and an internal sharp ridge proceeding from the margin towards the centre. The median part itself appears to have been injured, and very likely the cartilage-plate and the muscular ridges were broken off, but they could not have been of any considerable strength.

Locality.—Odium, in a brownish earthy limestone; apparently very rare.

Formation.—Ootatoor group.

VI. Order,—LUCINACEA.

Like every other group of animals which holds a certain intermediate position between a number of distinct types this order includes rather a varied assemblage of forms which it is very difficult to characterize in a few words. The families belonging to the order are the *LUCINIDÆ*, *UNGULINIDÆ*, *ERYCINIDÆ*, *GALEOMMIDÆ*, *SOLEMYIDÆ*, *ASTARTIDÆ*, and *CRASSATELLIDÆ*; they follow each other according to their relative relations, as far as it is possible to give an expression to this idea. The typical forms have the mantle margins disunited, and a single siphonal opening posteriorly, sometimes prolonged into a tube, but there never are two equally prolonged siphons present. However, many of the *LUCINIDÆ* possess two siphonal openings, the inhalant being sometimes produced; all the others have only one opening, except the *CRASSATELLIDÆ*, which appear to have none, though its place is indicated by a very thin commissure in the mantle, they thus form a transition to the next order. Again, the *GALEOMMIDÆ* and *SOLEMYIDÆ* have the inner mantle margins partially united, and recall the structure of some of the *MYACEA*. The form of the foot is variable, either vermiform and cylindrical, or angularly bent, as in some *Cardia*, or compressed, as in the *VENERACEA*. There is generally a pair of gills on each side of the body and one pair of palpi; rarely the latter become nearly obsolete.

Although some of the genera combine in their organisation characters which they have in common with higher organised Pelecypoda, the greatest number show a lower organised type, than that of any of the previous orders. The *LUCINACEA* must be considered as the type of Pelecypoda provided with only an exhalant opening, while the admission of water to the gills can take place in the entire extent of the disunited mantle margins. Somewhat different would be our conclusions had we to go simply by the characters of the shells in classifying them, for the greater number of them is closely allied to the *VENERACEA*, possessing a small number of hinge-teeth which fit alternately in the two valves; there are two muscular scars, and the pallial line is always entire. In the characters relating to the rounded or oval form, and the presence of cardinal and lateral hinge-teeth of the shell, the *LUCINIDÆ*, (and particularly the *CORBINÆ*), show a very great relation to the *CARDIIDÆ*; the *ERYCINIDÆ* and *GALEOMMIDÆ* recall the *MYIDÆ* and *ANATINIDÆ*, possessing a thin shell with few hinge-teeth and an internal cartilage; the *SOLEMYIDÆ* have a shell which differs from that of *Cyrtodaria* almost only by its thin structure, its general form being also that of many *SOLENIDÆ*; the *ASTARTIDÆ* have their nearest allies partially in the *VENERIDÆ*, partially in the *CYPRINIDÆ*, both in the form of the shell and the distribution of the hinge-teeth; and, lastly, the *CRASSATELLIDÆ* strongly recall the *MACTRIDÆ*. This association of shells so varied clearly indicates that further research has yet many gaps to fill up in the way of connecting links from one type to the other.

I will only briefly allude to the geological history of the order. The *SOLEMYIDÆ* appear to be the oldest of all; they certainly occur already in the

lowest palæozoic rocks, but continue sparingly up to the present time. The knowledge of the fossil forms is too imperfect to allow any certain conclusion to be drawn with regard to their relation to other allied shells. Next come the *ASTARTIDÆ*; they are rare in palæozoic rocks, but attain a very great development in the mesozoic period. The true *ASTARTINÆ* appear to have been the predecessors of the *CYPRINIDÆ* and *VENERIDÆ*, and from the *CARDITINÆ* may partially have sprung up the *CARDIIDÆ*, partially the *CHAMIDÆ* and allied forms. The *CRASSATELLIDÆ* appear to be an offshoot of the *ASTARTIDÆ*; they first appear in middle mesozoic rocks, and seem to have preceded the *MACTRIDÆ*, to some genera of which they exhibit, as already noticed, very marked relations. The *LUCINIDÆ* and *UNGULINIDÆ* are sparingly represented in mesozoic rocks, but seem to attain an extensive development during the first-half of the caenozoic or tertiary epoch, in which they perhaps had their maximum, for their number appears to decrease since that time. Their relations to the *CARDIIDÆ*, and partially also to the *TELLINIDÆ*, have been already alluded to, but the whole of the *Lucina* group of shells seems to be quite distinct from these. The *ERYCINIDÆ* and *GALEOMMIDÆ* are the youngest of the whole order, and they also possess more of the characters of the more highly organised Pelecypoda than any of the families previously mentioned. They are hardly known from older than caenozoic rocks, and very probably are mostly developed in the present seas. More careful studies of the minute shells of the tropical regions seem to promise great additions to the comparatively small number of species as yet known.

In the list of characteristic fossils the *ASTARTIDÆ* especially play a very important part.

XXIII. Family,—*LUCINIDÆ*.

The animals of the *LUCINIDÆ* are, like their shells, oval or roundish, generally somewhat tumid or moderately compressed, with the mantle margins separated in front and below, united for a short distance on the postero-ventral side, and leaving a wide gape posteriorly, in which terminate the two openings representing the siphons. The upper, anal or exhalant, generally is a simple oval or roundish hole, the lower, branchial or inhalant, is often more or less produced into a retractile siphon, sometimes provided with a fringed orifice. The edges of the mantle are entire, somewhat thickened, and the leaflets more or less distinctly attached to the inner surface of the valves, which on this account attain a rough appearance. The gills are very large, occupying the greater part of the sides, thick, according to Deshayes, sometimes composed of two to five layers of blood-vessels, but all united to a single fleshy lobe. The mouth is, according to the same author, very small, and the palpi in *Lucina* and its allies almost obsolete, being represented by a single labial tubercle. The same observation has been made on the animal of *Corbis*. The foot is cylindrical or vermiform, very elongated, and without a byssus, hollow internally, more or less easily retractile into the shell.

The shells all agree in their rounded or oval shape, solid structure, internally rugose surface of the valves, large oval muscular scars and entire pallial sinus.

The hinge varies greatly; in typical forms there are two cardinal teeth fitting alternately one behind the other, and one lateral tooth on each side; the ligament is external or sub-internal. In other closely allied forms either the laterals or the cardinals become partially or wholly obsolete, and again in others, all teeth are absent during all stages of age.

It appears to me that two groups or sub-families could conveniently be separated, though their definition is somewhat arbitrary. The first, *CORBINÆ*, has as type the genus *Corbis*; the shells are generally elongately ovate, or ovately rounded, solid, with muscular impressions sub-equal, broadly ovate, the ligament always external. The second, *LUCININÆ*, of which the type is *Lucina*, have a more or less orbicular shell, the anterior muscular impression is narrower and much longer than the posterior, the ligament is lodged in a deep groove or is sometimes nearly internal. As these two divisions appear also convenient for the grouping of the numerous fossil forms I shall here retain them. The following genera have to be classed in this family; (a), *Unicardium*, *Conchocele*, *Fimbriella*, *Gonodon*, *Sphæra*, *Mutiella*, *Sphæriola*, *Corbis*, *Corbicella*, *Sportella*, *Sphærella*; (b), *Philis*, *Cryptodon*, *Lucina*, (including the sub-genera *Loripes*, *Here*, *Codakia*, *Miltha*, *Myrtea*, *Cyclas*).

For the palæontologist the study of this family is of great importance, (there are several forms which may prove to be characteristic types), and to the conchologist its development is very interesting. The *LUCINIDÆ* make their first appearance already in silurian rocks, though the species agree with the type only in external shape. I am not aware that the determination of any of the palæozoic forms has as yet been authenticated by an examination of the hinge, but in most instances the species seem to possess great claim to accuracy of determination. In the Trias we have a few species of the *CORBINÆ*, some forms intermediate between both sub-families, like *Sphæra* and *Unicardium*, prevailing; the *LUCININÆ* are also represented, but not yet well discriminated. In the jurassic period the number of species of both sub-families gradually increases from the Lias upwards. The two groups which I have pointed out as sub-families appear to become clearly indicated. The *CORBINÆ* are decidedly more numerous and varied in form, the genera *Unicardium* and *Sphæriola* and probably *Sphærella* attain their highest development; typical *Corbis*, and most likely also *Fimbriella* and *Mutiella*, are also found; *Corbicella* is a new form, which again disappears with the beginning of the cretaceous period in which *Sphæra* is added to the number. As to variety of generic types, and perhaps even as to species, the two periods, jurassic and cretaceous, are nearly equal, but almost all these forms seem to disappear in the tertiary period, where we find *Conchocele* and *Sportella*, particularly the latter, very numerous; it is the representative of *Corbicella*. *Corbis* alone continues up to the present time, but the number of species decidedly decreases.

In the *LUCININÆ* the species gradually increase in number from the Lias, through the Dogger, Malm, and the whole of the cretaceous period. Some of the elongated sub-genera, like *Myrtea*, which in form approach the *CORBINÆ*, are here

more numerous than at the present time. If all the other eocene deposits be as rich in *LUCININÆ* as those of the Paris basin, the sub-family would seem to possess its greatest development during the time of that formation, for the total number of recent species is somewhat short of that which Deshayes describes from the Paris basin alone. In the present seas the distribution is universal, but the species seem to be with few exceptions far from common.

I will first give a review of the known genera, and then a list of those forms which have been recorded from cretaceous deposits. The South Indian rocks have yielded us examples of many of the generic types, and several very interesting new species :—

a. *Sub-family*,—*CORBINÆ*.

1. *Unicardium*, d'Orb., 1850, (Prod. de Paléont., i, p. 218). Shell elongately oval, or ovally rounded, sub-inequilateral, of moderate thickness, beaks tumescent, incurved and close together, surface concentrically striated, hinge with one conical cardinal tooth in each valve, sometimes becoming obsolete or nearly so, fulcra long and prominent, separated from the margin by a deep furrow in which the ligament is lodged. Type, *U. cardioides*, Phillips, sp. (*Corbula id.*), from the Lias. The species of *Unicardium* are as yet chiefly known from jurassic beds; there are some triassic species described under the names of *Lucina* and *Corbis*, which may belong to it, but their hinges have not yet been made known. In cretaceous deposits the genus becomes apparently very rare.

2. *Conchocele*, Gabb, 1866, (Pal. Calif., vol. ii, p. 27). Shell sub-quadrate, posteriorly less high and elongated, being very inequilateral, a ridge passing from the beaks to the posterior end, hinge edentulous, hinge area somewhat thickened and insinuated under the beak with a single long rib-like tooth extending from the beak to the posterior end. Type, *C. disjuncta*, Gabb, from tertiary beds of California. As to internal characters this genus hardly appears to differ from some forms of *Unicardium* in which the cardinal tooth is obsolete, but the shape of the shell is different.

3. *Fimbriella*, Stol., 1870. Shell sub-orbicular, moderately tumid, sub-equilateral, with prominent, obtuse incurved beaks, surface partially smooth, partially finely punctated or spinulose; lunular edge in front of the beaks somewhat expanded, as in the two following genera; hinge in each valve with two conical or sub-tubercular cardinal teeth: those of the right are superimposed, the upper one being situated on the enlarged lunular margin, those of the left valve are situated beside each other, the anterior much stronger than the posterior, no lateral teeth are present, but the margin is posteriorly internally slightly grooved; the ligament must have been thin, for there is only a short very narrow space immediately behind the beaks for its attachment, no special nymphæ being present. Type, *Corbula lævigata*, Sow., (Min. Conch., iii, p. 16, pl. 209, figs. 1-2), a cretaceous shell from the Blackdown sandstone; it has been transferred by d'Orbigny to *Unicardium*, but differs by the number and position of

the hinge-teeth from this genus. This typical species has internally a short posterior rib extending from the beak to about half the height of the shell, terminating near the posterior muscular impression, and the impression of this rib on the cast appears to have led to its having probably been taken as indicating a deep pallial sinus, and consequently it was thought to belong to *Thetironia* = *Thetis* of Sowerby. The species also greatly recalls the genus *Serripes* (of the *CARDIIDÆ*), but it seems to differ from it sufficiently by the form and position of the cardinal teeth and the total want of lateral teeth, though a further close comparison of perfect specimens of both genera would be very desirable.

4. *Gonodon*, Schafhæutl, 1863, (Süd-Bayerns Leth. Geog., p. 382). *Iso-cardia ovata*, Goldf., (from jurassic rocks) is taken as the type of this genus. The shell is ovate, tumid, apparently smooth; the hinge of the right valve is described as consisting of a very large median semi-circular broad tooth with the sharpened edge turned upwards, that of the left valve with an equally large corresponding pit below bounded by a long thick tooth somewhat smaller than that of the other valve; the posterior margins of the hinge are thickened in both valves. This genus is evidently allied to *Unicardium*, but seems to differ by the enormous development (natural?) of the teeth.

5. *Sphæra*, Sow., 1822, (Min. Conch., iv, p. 41, pl. 335; *Palæocorbis*, Conrad, 1869, Am. Journ. Conch., v, p. 101). Shell ovate, inflated, solid, sub-equilateral, hinge of left valve with two blunt cardinal teeth, the posterior much smaller and separated from the larger anterior by a pit, lunular edge somewhat extended with a deep pit and a swollen tooth-like margin above and below it, posteriorly with a furrow near the fulcral margin and several cross teeth at the posterior end, ligament in a long excavated furrow. Type, *Sphæra corrugata*, Sow. = *Corbis cordiformis*, d'Orb., from the Neocomien. Mr. Conrad forgot to notice the identity of the species and hence a new generic name!

6. *Mutiella*, Stol., 1870. Shell oblong, sub-equilateral, tumid, with obtuse incurved beaks, hinge in the left valve with two cardinal teeth, the anterior one being sometimes bifid, in the right valve there is a single large bifid cardinal tooth; lunular edge expanded, with several teeth, or with more or less distinct corrugations, representing anterior lateral teeth, posterior hinge side straight with a furrow near the margin for the ligament, and an indistinct terminal posterior lateral tooth. Type, *Corbis rotundata*, d'Orb.

This genus differs essentially by the characters of the hinge from the previous; there are several middle and upper cretaceous species which belong to it, but none are known from more recent deposits.

7. *Sphæriola*, Stol., 1870. Shell rounded, globose, nearly equilateral, with concentric striæ or sulci on the surface, hinge with two diverging cardinal teeth in each valve, the anterior being somewhat elongated and nearly horizontally extended. Type, *Sphæra Madridi*, d'Arch., (vide Morris and Lycett, Foss. Great Ool., part ii, p. 71); the absence of lateral teeth and the usual rounded and globose form readily distinguish this genus from the next. Some species belonging to it are

already met with in triassic beds, and others occur in the Lias and Dogger, but no cretaceous species has yet been sufficiently ascertained. The genus had been mistaken for *Sphæra*, under which name also most of the species appear to have been described.

8. *Corbis*, Cuv., 1817, (*Gafrarium*,* Bolten, apud H. and A. Adams). Shell oval, sub-equilateral, moderately tumid, usually with cancellated surface, hinge with two cardinal, one anterior and one posterior lateral tooth, ligament long, situated in a groove; muscular impressions oval, the anterior generally somewhat larger than the posterior. Type, *C. fimbriata*, Linn.

The species of *Corbis* occur through all the mesozoic and tertiary strata, but they are always rare shells; equally so are the few recent species as yet known. The triassic species like *C. laticosta* and *plana*, described by Laube from St. Cassian (Denksch. Akad., Wien, xxv, pt. ii, pp. 38 and 39, &c.) may be compared with *Erycinella* in the form of the hinge-teeth.

9. *Corbicella*, Morr. and Lycett, 1853, (Moll. Great. Ool., pt. ii, p. 94). Shell ovately elongated, rather compressed, (tellinoid), sub-inequilateral, anteriorly rounded, posteriorly a little less high and obliquely truncate at the end, hinge in the left valve with one large anterior lamina-like, and another smaller bifid posterior cardinal tooth; in the right valve there is one small anterior and one large posterior cardinal, and in each one posterior lateral. The type of the genus is *Corbis* (*Corbicella*) *Bathonica*, M. and L., from oolitic beds near Minchinhampton. Morris and Lycett state that the anterior lateral tooth is always wanting, but though not well developed, it is certainly indicated by the internally strongly thickened margin in such species as *Corb. depressa*, Desh., and still more in *Corb. Barrensis*, Buv., (vide Lorient and Cotteau, Mon. Pal. and Geol., &c., Portlandien, 1868, pl. 10, figs. 5 and 6). The tellinoid compressed form of these shells and their ornamentation, consisting merely of fine striae of growth, shows a great similarity to *Mactromya*, Ag., and readily distinguishes the genus from *Corbis*, but the hinge,—judging from the variation of the teeth in the different species,—does not appear essentially to differ from that of this last named genus.

10. *Sportella*, Desh., 1860, (Paris foss., 2nd edit., i, p. 593). Shell ovately elongated, sub-equilateral, moderately compressed, with sub-parallel upper and lower margins; hinge in the left valve with two diverging unequal cardinal teeth, the posterior being somewhat elongated, in the right with a large single median and a small anterior cardinal tooth. Type, *S. Caillati*, Desh., from the eocene beds of the Paris basin.

I am not acquainted with any cretaceous or older species belonging to this genus. Deshayes (l. cit., p. 594), says that some jurassic and other species of *Sportella* have been included by Agassiz in his *Mactromya*. It would have been

* Bolten's name can hardly be accepted for this genus, for it was actually proposed for a mixtum compositum of the most varied genera of shells, and it is doubtful which should be taken as the type. M. v. Mühlfeld's name *Fimbria* (1811) is pre-occupied by that of Bohadsch in 1761, and of the contemporaneous names *Corbis* and *Idothea*, the former certainly deserves preference on account of its having been almost generally accepted by conchologists, though it was only lately given up by Deshayes and his followers for that of *Fimbria* which cannot be adopted.

Glofus? Moreanensis.

Pl. fig.

Cyprina cordata, Meek & Hayden, Proceed. Acad. Nat. Sci. Phila. May 1857 p. 143.
Not. Glofus [Locardia] cordata, Born.

Bucardia? Moreanensis " " " " " " " " Oct. 1860 p. 427.

Glofus? Moreanensis, Gabb, Cat. Brit. Foss. March 1861.

easier to settle this question, if Deshayes had in such a case as this pointed out the species to which he particularly refers, for, as the statement now stands, it seems to be only a guess. There are no doubt several of Agassiz' *Mactromyæ* in external form almost identical with *Sportella*, but they again so perfectly resemble other species in which the muscular impressions and pallial sinus indicate a generic difference, that it does not appear at all probable that any of them belong to *Sportella*. Such is at least the opinion which one is forced to accept by a comparison of Agassiz's drawings; the examination of original specimens may, of course, lead possibly to different results. Deshayes further states that Sowerby's *Corbis lævis* (Min. Conch., vi, pl. 580,) is a *Sportella*. Sowerby shows in the only specimen which he examined a large anterior lateral tooth and the posterior is said to have possibly been worn away, but even should this not have been the case, the species could not belong to *Sportella*; it may, however, be a *Corbicella*.

11. *Sphærella*, Con., 1838, (Tert. foss., p. 17, and Journ. Acad. N. S., Phil., iv, p. 280). Shell rounded, tumid, thin; hinge with two cardinal teeth in each valve, the posterior one in the right valve broad, bifid, parallel to the hinge margin, in the left single, but equally elongated; type, *Sph. sub-vexa*, Con., from tertiary deposits; the genus also occurs in cretaceous and older mesozoic deposits, but appears to be very scarce. Laube described one species, *Lucina anceps*, from the St. Cassian beds (vide Denksch. Akad., Wien, xxv, pt. ii, p. 36, pl. 15, fig. 5). Even some of the palæozoic *Lucinæ* may belong to the genus. Conrad and others class it near *Diplodonta*, but the prolonged posterior teeth appear to indicate a greater relation to the various *CORBINÆ* than to the *UNGULINIDÆ*.

b. Sub-family,—*LUCININÆ*.

12. *Philis*, Fischer, 1864, (Journ. de Conch., ix, p. 345). Shell ovate, higher than long, inflated, thin, finely concentrically striated and with a posterior duplication extending from the beaks; hinge edentulous, lunula small and very deep, forming a kind of a roundish or spoon-shaped process below the beaks; muscular impressions rounded. Type, *Ph. Cumingii*, Fisch., from the Moluccas.

13. *Cryptodon*, Turton, 1822. Shell sub-orbicular, somewhat higher than long and with a deep groove extending from the beaks to the postero-inferior margin, thin, lunule distinct; hinge with a single cardinal tooth in the right valve; ligament thin, linear, marginal; muscular impressions roundish oval. Type, *C. flexuosus*, Mont. The few species known live in the northern seas and in deep water.

14. *Lucina*, Brug., 1792. Shell rounded, sub-orbicular, moderately compressed, or more or less inflated and solid, ligament situated in a deep groove, sometimes nearly internal; hinge with two cardinal and two lateral teeth, one or the other often becoming partially or wholly obsolete; anterior muscular impression large, elongated, more or less prolonged towards the centre of the valves; posterior, oval, sub-marginal; pallial line distinct, sometimes partially or locally interrupted; internal layer of shell within the pallial line distinctly rugose, opaque; lunule usually deeply excavated.

The species of *Lucina*, though not so numerous as those of *Tellina*, offer a somewhat similar amount of variation. Although some of them appear at first sight to represent very different types, they are upon a comparison of large materials connected by so many intermediate forms that it does not seem advisable to give them a higher than a sub-generic rank. Deshayes in his valuable contribution to the anatomy of the *Lucinæ* (Journ. de Conch., 1861, ix, p. 317,) has, I think, sufficiently proved that there is an intimate connection existing between all the recent species of *Lucinæ*, all possessing in common the more or less orbiculate form, moderately curved hinge-line either with well developed cardinal and lateral, or with partially or wholly obsolete teeth, a large anterior muscular impression, rugose surface of the internal shell, the mantle being partially attached to it, &c. The animals in all the species which Deshayes examined were very similar. At the same time, however, it cannot be denied that there are several well marked groups of *Lucina*, and following H. and A. Adams and others, I shall retain them, as already noticed, as sub-genera. They are, it is true, chiefly based upon some variations in the external shape and upon the ornamentation, characters which at first sight appear very subordinate. But there can be no doubt that several of them are well founded distinctions, which can be traced from the present time through all the tertiary, cretaceous, and in some cases even into the jurassic deposits.

a. The name *Lucina* has been reserved for the species of the type of *L. Jamaicensis*, Spengler; the shells are roundish, oval, or orbicular, concentrically lamellated or striated, moderately tumid; cardinal and lateral teeth, as a rule, well developed.

b. *Loripes*, Poli, 1791, type, *L. lactea*, Linn.; similar in form to *Lucina*, but usually more tumid, either the lateral or the cardinal, or all the hinge-teeth, become obsolete; ligament sub-internal, sometimes quite closed up in a furrow of the posterior hinge margin.

(a). There are four somewhat different types of recent *Loripes*, the one represented by the above-mentioned type species, and a few others; the shells are usually moderately compressed, orbicular, with fine concentric striæ on the surface; the right valve has one rather large cardinal tooth, the left two smaller teeth, the anterior being placed parallel to the lunular margin; the ligament is almost quite internal. This group appears to be purely marine.

(β). The second group is represented by species like *Luc. barbata*, *ovum*, &c.; they are generally strongly inflated and have all the hinge-teeth obsolete or nearly so; these are also mostly purely marine shells.

(γ). The third sub-division is represented by *Luc. Philippinarum*, Hanley; the shells are comparatively thick, concentrically coarsely lamellated, covered with a horny epidermis, the teeth are either obsolete, or there is one blunt cardinal tooth in one and a simple groove in the other valve; usually the anterior, but very rarely the posterior lateral teeth are developed, all, as a rule, become obsolete in old specimens. The species belonging to this group mostly live in brackish water and in estuaries.

(δ). To these three divisions I add provisionally a fourth one, which Gabb (Pal. Calif., ii, 1869, p. 188,) proposed for his ? *Loripes dubius* and named *Clissocolus*. The shell is sub-orbicular, thin, with the ligament lodged in a deep groove, the right valve has the hinge margin slightly thickened under the beak, the left with an obsolete tubercle; "pallial line unknown," but I hardly expect that the shell is different from the second group of *Loripes* I mentioned.

c. *Here*, Gabb, 1866, (Pal. Calif., ii, p. 28). Shell sub-orbicular, globose, concentrically striated, anterior lateral and cardinal teeth well developed, as in *Lucina*, but the lunule is very deep, extending across the hinge area between the anterior lateral and the cardinal teeth. Type, *Luc.* [*Here*] *Richthofeni*, Gabb, from tertiary beds of California. It seems very doubtful that the excavation of the lunule is a character sufficient for separating this shell from *Lucina*, unless there is some difference in the internal structure and the muscular impressions, as is, for instance, the case in *Philis*. Gabb suggests that two recent species living on the Pacific coast should also be referred to *Here*, *Luc. excavata*, Carp., and another, with six large rounded ribs, occurring in the Gulf of California. If we, however, principally base the sub-genera upon the character of ornamentation, the costate species would rather be referable to the next group.

d. *Codakia*, Scop., 1777. Shell sub-orbicular or obliquely oval, compressed, radiately ribbed, the areal edges behind the beaks almost entirely enclosing the ligament, hinge-teeth regular and generally complete; type, *Luc. tigerina*, Linn.

e. *Miltha*, H. and A. Adams, 1857. Shell roundly ovate, rather high, concentrically striated, and more or less distinctly radiately ribbed; hinge with the lateral teeth sometimes obsolete; type, *Luc. Childreni*, Gray. As this species shows fine radiating ribs, the more distinctly ribbed but sub-orbicular species, like *Luc. scabra*, Lam., and others, could be referred to this sub-genus, if not to *Codakia*, for many of that group, referred by H. and A. Adams to *Myrtea*, possess well developed lateral teeth.

f. *Myrtea*, Turt., 1822. Shell ovately elongated with a long hinge area, compressed, concentrically striated, hinge with the lateral teeth sometimes obsolete; type, *Luc. spinifera*, Mont., sp. The only other recent species which should be retained in this sub-genus is *Luc. fabula*, Reeve; all the others noted by H. and A. Adams may better be placed in *Miltha*. Forms of the typical species, *Luc. spinifera*, already occur in jurassic and cretaceous rocks, and some of those have the lateral teeth distinct, others not, but the shape of the shells appears to remain constant.

g. *Lirodiscus*, Con., 1869, (Am. Journ. Conch., v, p. 46). Shell sub-quadrangular, concentrically ribbed, posterior side lobed by an impressed line; hinge with two cardinal teeth in each valve, right valve with a small pyramidal anterior lateral tooth, left with a posterior one distant from the cardinals; type, *Ast. tellinoides*, Con., from eocene rocks. The author suggests that the cretaceous *Astarte sinuata*, d'Orbigny, may belong to the same genus. I believe it to be a sub-genus of *Lucina*, and it seems doubtful whether it be sufficiently distinguishable from *Myrtea*.

* Nonsense — The shell has not the elongated anterior
margin, nor the general appearance of *Lucina*.

h. Cyclas, Klein, 1753. Shell orbicular, moderately compressed, thin, hinge-teeth generally complete, but very small, surface with regular concentric striæ of growth, covered with a kind of polished coating, which is angularly and divaricately striated; type, *Luc. divaricata*, Linn. Species of this type already occur in cretaceous deposits.

LIST OF CRETACEOUS SPECIES.

a. CORBINÆ, vide genus *Fimbria* in Pictet and Campiche, Pal. Suisse, 4^{me} ser., 5^{me} liv., p. 283.

1.—*F. corrugata*, Sow., is the type of Sowerby's *Sphæra* and of Conrad's *Palæocorbis* (see p. 247).

2-5.—*F. gemmifera*, P. and C., *Michaillensis*, P. and C., *fibrosa*, Forb., *Gaullina*, P. and R., are not known by the hinge-teeth; the forms agree with *Corbis*, excepting the first named species, which may also be a *Lucina* (sub-genus *Codakia*).

6.—*F. rotundata*, d'Orb., is the type of the genus *Mutiella* (see p. 247).

7.—*F. Verneuilli*, Guéranger, (*Corbis id.*, Album paléont. de la Sarthe, 1867, pl. xix, fig. 8), is a small concentrically lamellated species of *Mutiella*. Guéranger also gives two figures on the same plate of the last named species.

8.—*F. striatocostata*, d'Orb., probably belongs to the same genus as the last, or to *Sphæriola*.

9.—*F. Salignaci*, Coq., not known from the hinge.

10.—*F. coarctata*, Zitt., is a *Mutiella*.

11-12.—*F. multilamellosa* and *sublamellosa*, d'Orb., uncertain.

13.—*F. Tevesthensis*, Coq., from Algiers, appears to be a true *Corbis*.

14.—*Corbis sublaevis*, Keys., (Petschora-reise, pl. 17, figs. 12-13,) is apparently a true *Corbis*, and doubtfully referred by Eichwald to the Neocomien (Leth. ross., xi livr., 1867, p. 641).

15-16.—*Luc. heteroclita*, d'Orb., (Eichwald, *ibid.* p. 647,) is a *Unicardium*, and the same may be the case with *Luc. rostrata*, Eichw., (*ibid.* p. 649); both rather appear to resemble jurassic more than cretaceous types.

17.—*Unicardium inornatum*, d'Orb., (*Card. idem*, Pal. franç. cret., pl. 256, figs. 3-6).

18.—*Fimbriella laevigata*, Sow., sp., see p. 246.

19-20.—*Sphærella concentrica*, Con., Journ. Acad. N. Sc., Ph., ii, p. 280, is from the Alabama cretaceous rocks; and *Sph. oregon*, Con., is quoted by Conrad from the lower eocene (? cretaceous) of Oregon, (see Check-list eocene foss., Smith. Misc. Coll., No. 200, 1866, p. 6).

In the South Indian cretaceous rocks the following three species occur:—

21-23.—*Mutiella exigua*, *Corbis typica*, and *oblonga*; all are from the highest beds, the Arrialoor group.

b. LUCININÆ, vide *Lucina* in Pict. and Camp., Pal. Suisse, l. cit., p. 290.

24-28.—*L. Germani*, *vermicularis*, *Cornueliana*, *Dupiniana*, and *Rouyana* appear to be true *Lucinæ*.

29.—*L. Robinaldina* is quite uncertain.

30.—*L. globiformis*, Leym., has more the form and structure of a *Mysia* (= *Diplodonta*) than of a *Lucina*.

31.—*L. Urganensis*, Lor., Rech. Geol. de la Savoie, &c., par A. Favre, tom. i, 1867, p. 377, pl. c, fig. 13; the posterior radiating striation of this species strongly recalls *Linearia*, (*TELLINIDÆ*).

32.—*L. ? solidula* I would suspect to be a *Mysia*.

33-34.—*L. Valdensis* and *sculpta* are apparently true *Lucinæ*.

35.—*L. Vibrayeana* has the external form of the sub-genus *Myrtea* of *Lucina*.

36-37.—*L. Sanctæ-crucis* and *Arduennensis* may rather belong to *Mysia* than to *Lucina*.

38.—*L. ? orbicularis*, Sow.; this looks more like a *Limopsis* than a *Lucina*.

39.—*L. pisum* is a true *Lucina*.

40.—*L. Turoniensis* is either a *Mysia* or a *Lucina*.

41-45.—*L. Nereis*, *sub-pisum*, *Campaniensis*, *Michelini*, *Harlei* are apparently *Lucinae*.

[*L. lenticularis*, Goldf., is one of the typical species of *Eriphyla*, Gabb, vide p. 156].

46-52.—*L. producta*, *lobata*, *sub-numismalis*, 1850 (= *tenuis*, Müller, Petref. Aach. Kreid., pt. ii, 1851, p. 66), *Geinitzi*, *cretacea*, (vide Favre, Descrip. M. foss. de Lemberg, 1869, p. 115), *sub-squamulata* and *supra-cretacea*, all appear to be true *Lucinae*.

53-56.—*L. inæqualis*, *corbisoides*, *Phillipsiana*, and *Fischeriana*, d'Orb., (Eichwald, Leth. ross., xi livr., 1867, p. 648, and Murchison, Ver. and Keys. Pal. d. Russ., pl. 39, figs. 1-8, and pl. 38, figs. 31-32.) are apparently *Lucinae*; Eichwald quotes them from neocomien beds.

57.—*L. discors*, Eichw., ibid. p. 656, pl. 24, fig. 8, belongs to the sub-genus *Cyclas* of *Lucina*.

Eichwald also mentions *L. Roissyi*, Leym., as occurring in neocomien beds of Russia; the species belongs more probably to the family *VENERIDÆ*, than that it should represent a *Lucina*.

58-59.—*L. Nicasei* and *Masylæa* are described by Coquand from the Province Constantine, Algiers.

60-65.—*L. occidentalis*, *parvilineata*, *pinguis*, *sub-lenticularis*, *subundata*, and *ventricosa* are recorded by Meek in his Check-list of North Am. cret. foss., Smiths. Misc. Coll., No. 177, 1864.

66.—*L. plicatocostata*, d'Orb., Voy. d. l' Am. merid., pl. 18, figs. 13-14. *L. excentrica*, Sow., Darwin, South America, pl. 5, fig. 21.

67-68.—*L. Grangei* and *Dumoulini* (? *Desmoulini*, Index to Prod. iii, p. 89), Voy. Astrol. Pal., pl. 2, are also from South America.

69-74.—*Clissocolus dubius*, *Lucina nasuta*, *postice-radiata*, *subcircularis*, *cumulata*, and ? *L. cretacea*, are noted by Gabb from California (Pal. Calif., ii, p. 243).

75-77.—From Conrad's Check-list of eocene foss. of N. America, (Smiths. Misc. Coll., No. 200, p. 6,) are to be noticed *L. acutilineata*, *fibrosa*, and *gyrata*, (*Dosinia* apud Gabb, Pal. Calif. vol. i).

78-80.—In Lynch's Exp.' report are noted by Conrad from Palæstine *L. syriaca*, *sub-truncata*, and *safedensis*; the two former are imperfect casts, the third is a nearly circular, concentrically lamellated *Lucina*.

81-86.—In South India the following six species occur:—*Lucina* [*Codakia*] *percrassa*, *L. fallax*, *L. nudata*, *L. [Cyclas] tæniolata*, *L. [Myrtea] Arcotina*, *L. [Myrtea] dentigera*.

All the nine species of South Indian cretaceous *LUCINIDÆ* occur in the Arrialoor group; only one is found also in the Ootatoor group, and another species is met with in all the three groups.

As regards the representation of the whole family in cretaceous beds, there can be no doubt that the number of species sensibly increases from the lower into the higher beds, and equally so does the number of generic and sub-generic types.

MUTIELLA, Stol., 1870, (see p. 247).

✓ 1. MUTIELLA EXIGUA, Stoliczka, Pl. XIII, Fig. 5.

M. testa ovulata, tumida, fere æquilaterali, umbonibus paululum prominulis, obtusis, incurvis; superficie concentrice rugose lamellata; margine lunulari expanso, levissime curvato, margine areali subrecto, modice declivi; cardine in valva sinistra dentibus duobus cardinalibus lamelliformibus et unico postico laterali elongato tuberculo parvo terminanti instructo; expansione cardinali interne obsolete rugulata (? bidenticulata).

Height of shell	:	its length	...	...	...	...	0.85
Thickness	„	„	...	...	...	...	0.71

The concentric lamellæ are very characteristic for this comparatively small species of *Mutiella*; there was most probably also a fine radiating striation between

them, but the only specimen we possess has not the surface in such a good state as to show this sufficiently clearly. In the left valve the beak is curved anteriorly; immediately below it there is a lamelliform tooth, and a second one a little in front and below it; one narrow ridge runs the whole length of the areal margin and terminates with a small posterior tubercular tooth.

Locality.—Olapaudy, in an oolitic brownish calcareous and earthy rock; apparently very rare.

Formation.—Arriallor group.

? *Sphæriola*, sp. ind.

Only two imperfect cast specimens of a small, rounded, tumid, concentrically lamellated species were met with in the light coloured Arriallor sandstone near Strípermatúr, in company with *Hippagus Aemilianus*. One valve is 5 m. m. long, $4\frac{1}{2}$ m. m. high, and 2 m. m. thick. In external appearance the shell resembles some of the jurassic species of *Sphæriola*, but it is impossible to trace the hinge-teeth. The discovery of better materials will, it is hoped, settle the determination of this species.

CORBIS, Cuv., 1817, (see p. 248).

1. CORBIS TYPICA, Stoliczka, Pl. XIII, Figs. 11-12.

C. testa subquadrangulariter ovata, subæquilaterali, antice late rotundata, postice angustata et oblique sub-truncata, umbonibus valde tumidis, latis, antice versus incurvis, approximatis; lunula parva, profunda, lævigata; margine areali subrecto, declivi; margine ventrali leviter curvato; superficie costulis concentricis crassis confertis antice ac postice sulcis radiantibus decussatis et in medio striis tenuioribus radiantibus ornata; cardine dentibus duobus cardinalibus et lateralibus instructo, laterali antico multo crassiori quam postico, et cardinalibus approximato; ligamento in excavatione profunda sito; margine interiori omnino crasse et pliciforme denticulato.

Height of shell	:	its length	...	...	...	...	0.80
Thickness	„	„	...	...	...	...	0.60

This is a typical species of *Corbis*, in form and ornamentation resembling the recent *C. fimbriata*, but higher and more attenuated posteriorly; the radiating striation is at both ends much stronger than in the middle of the shell, where it is only observable in the depressions separating the concentric ribs.

We have received from the late L. Seeman of Paris a species under the name of *Corbis subclathrata* from the so-called Asphalt-beds (Kimmeridgien) of Hanover. This species is very closely allied to our cretaceous shell, it only appears to be a little more flexuous posteriorly.

Locality.—Ninnyoor, in a white earthy limestone; apparently rare.

Formation.—Arriallor group.

2. CORBIS OBLONGA, *Stoliczka*, Pl. XIII, Fig. 10.

C. testa ovato oblonga, fere æquilaterali, compressiuscula, concentrice crasse costata et radiatim minute striata, striis confertis, antice ac postice paulo fortioribus quam in medio; parte antica lata, ad marginem lente curvata, postica angustiore; margine areali valde declivi, rectiusculo, postico subrotundato, margine inferiori, seu ventrali, undulatim leviter convexo; lunula elongata, angustissima, lævigata; cardine duobus dentibus cardinalibus et lateralibus instructo, dente laterali antico remoto; ligamento profunde sito; margine interno crenulato.

Height of shell	:	its length	...	...	...	...	0.80
Thickness	„	„	...	...	...	...	0.40

The more compressed valves and the remote anterior lateral tooth essentially distinguish this species from the last. The concentric ribs are strong and sharp, but the radiating striæ very fine, and not much more distinct at both the ends of the shell than they are in the middle. The valves are nearly equilateral and, what is rarely the case in this genus, the anterior broad end almost a little longer than the posterior.

Locality.—Ninnyoor, in white limestone with the previous species.

Formation.—Arrialoor group.

LUCINA, *Brug.*, 1792, (see p. 249, &c.).1. LUCINA [CODAKIA] PERCRASSA, *Stoliczka*, Pl. XIV, Figs. 1-2.

Luc. [Cod.] testa rotundate quadrangulæ, sub-æquilaterali, crassissima, moderate convexa, sub-lævigata, prope peripheriam striis impressis distantibus incrementi et lineis radiantibus intersectis precipue in parte antica distinctis suppeditata; antice late rotundata, postice subtruncata, infra subrecta seu levissime insinuata; lunula profunda, ovata; areæ marginibus declivibus, subrectis, ligamentum profundum fere omnino tegentibus. Cardine dentibus cardinalibus crassissimis, dente laterali antico crassiori quam postico cardinalibus valde approximato instructo; margine interno crasse dentato; impressione musculari antica valde elongata, postica ovata; impressione palliali profunda, continua.

Height of shell equal to its length, or very little longer; thickness equal to half the length, or a little more.

There is scarcely another species of *Lucina* known which equals the present one in the thickness of the shell and its large, roundly quadrangular size. Its external form greatly recalls an *Axinæa* (= *Pectunculus*, Lam). Some of our largest specimens are 150 m. m. long, and the shell near the beaks is sometimes 20 m. m. thick; naturally the hinge-teeth are also very strongly developed; the anterior lateral is much stronger than the posterior and quite close to the cardinals.

The external surface is almost smooth in the greater number of specimens, but when well preserved it shows towards the margin a number of distant concentric striæ indicating stages of growth, and also some radiating impressed lines, which are generally most distinct on the broader anterior end. The internal

margin is wholly toothed, which is not very usual in *Lucina*, and this, as likewise the great thickness of the shell, rather partakes of the characters of *Corbis*; but as the anterior muscular scar is considerably more elongated than the posterior, and extends within the space included by the pallial impression, I consider the generic determination as a *Lucina* to be the more correct one.

Locality.—Ninnyoor, in white limestone; common.

Formation.—Arrialoor group.

2. LUCINA FALLAX, *Forbes*, Pl. XIII, Figs. 13, 15-17; and Pl. XIV, Figs. 3-5, 7-8.

1846. *Luc. fallax*, *Forbes*, *Trans., Geol. Soc., London*, vii, p. 143, pl. xvii, fig. 8—*idem* auctorum.

L. testa orbiculata, nonnunquam paulo longiore quam alta, æquilaterali, plus minusve compressa, ad marginem interdum lamellose incrassata (vide tab. xiii, fig. 13), in superficie lamellis acutis concentricis distantioribus et striis minutissimis interpositis ornata; lunula parva, excavata; area elongata, angustissima, profunda, ligamentum marginibus acutatis fere omnino tegente; cardine dentibus cardinalibus et lateralibus sicut in Lucinis typicis instructo; testæ superficie interna minute scrobiculata; impressione musculari antica angusta, valde elongata atque flexuose curvata, postica brevior; margine interno lævigato.

	Pl. xiii, fig. 13.	Pl. xiii, fig. 16.	Pl. xiv, fig. 3.	Pl. xiv, fig. 5.	Pl. xiv, fig. 7.
Height of shell : its length...	0·97	0·90	0·89	0·93	1·04
Thickness „ : „ ...	0·61	0·40	0·42	0·46	0·50

This is an extremely variable species. Its form is always more or less approaching to orbicular with slightly prominent median beaks; the lunula is small and excavated, the areal margins sharp and almost touching each other above the ligament; the surface is covered with numerous sharp concentric lamellæ, between which fine striæ* are situated; sometimes the lamellæ are especially numerous near the margin, producing here a great thickness of the shell. The hinge-teeth, the finely scrobiculate internal surface of the shell, muscular scars, and pallial impression do not differ in any marked way from those of other *Lucinæ*.

With regard to form and thickness of the shell several varieties may be distinguished.

The specimens figured on pl. xiv, figs. 3-5, may be regarded as typical; the shells are sub-orbicular, slightly longer than high, and the valves are very evenly rounded, the thickness of the shell being more than $\frac{2}{5}$ ths of its length.

Figs. 15-17 on pl. xiii represent a compressed variety, the shells are also somewhat longer than high, the valves are tumescent near the beaks, but much attenuated towards the margin; the thickness of the shell is not more than $\frac{2}{5}$ ths of its length.

Figs. 7-8 on pl. xiv represent a third variety, the shells are nearly orbicular, with pointed beaks, with thick convex valves; the thickness of the shell is equal to one-half of its length.

* These are not sufficiently well expressed in figs. 3 and 5 of pl. xiv.

Fig. 13, pl. xiii, represents a fourth variety, which in form closely resembles the last, but the thickness is more than one-half the length of the shell, being especially great near the margins.

I was first much inclined to regard some of these varieties as distinct species, but a careful comparison of the specimens shows that the different forms are closely connected with each other, and no doubt all represent one and the same specific type of shell.

Localities.—All the specimens were obtained from a dark brown earthy limestone near Moraviatoor, except a single specimen, figured on pl. xiii, fig. 17, which is from the white limestone near Ninnyoor.

Formation.—Ootatoor and Arrialoor groups.

3. LUCINA UNDATA, Stoliczka, Pl. XIII, Fig. 14.

L. testa quadrangulari, orbiculata, fere æquilaterali, moderate convexiuscula, umbonibus tumidulis, incurvis, acutiusculis et carina obtusiuscula ab umbonibus ad marginem postero-inferiorem decurrente instructa; superficie striis incrementi minutissimis sub-obsolete tecta; lunula haud profunda; ligamento in excavatione brevi pone umbones sito.

Height of shell equal to its length.

Thickness „ : its length 0.55

The only figured specimen I have seen of this shell does not show the hinge-teeth, but judging from external characters it seems to be a *Lucina*, for the structure appears to be a little too solid for a *Mysia* (= *Diplodonta*); still a careful comparison of well preserved specimens with the last named genus would be very desirable. The striæ of growth on the surface are almost obsolete; the somewhat squarish orbicular form with a posterior plicature and the want of a distinct lunula readily distinguish this from the last species.

Locality.—South-east of Arrialoor, in a whitish sandstone.

Formation.—Arrialoor group.

4. LUCINA [CYCLAS] TÆNIOLATA, Stoliczka, Pl. XIII, Fig. 9.

L. [Cycl.] testa fere orbiculata, parvula, tenui, paulo convexiuscula, superficie nonnullis lineis impressis incrementi ac striis lamelliformibus confertissimis per longitudinem leviter flexuose percurrentibus ornata; margine lunulari paulo incurvo, lunula angusta, elongata, mediocriter profunda, haud distincter circumscripta; impressionibus muscularibus regularibus,—dentes cardinis non vidi.

Height of shell : its length 0.94

Thickness* „ : „ 0.30

This is one of the very few species from cretaceous rocks belonging to the sub-genus *Cyclas*, characterized by its comparatively thin shell and longitudinal

* In fig. 9b on pl. xiii the shell is shown to be more compressed than it actually is; the convexity of the valves should be appreciably stronger.

undulating or divaricate striation, which is quite independent from the striæ indicating stages of growth. In the present species the longitudinal striæ are very numerous and only slightly curved, but the total form of the shell exactly corresponds to that of its recent and cainozoic allies.

Locality.—Ninnyoor, in white limestone; apparently rare.

Formation.—Arrialoor group.

5. LUCINA [MYRTEA] ARCOTINA, *Stoliczka*, Pl. XV, Figs. 1-5.

L. [Myrtea] testa trapezoidali, longiore quam alta, compressiuscula, margine lunulari paululum insinuato, valde declivi, areali levissime convexo, antice subrotundata, postice oblique truncata; superficie striis concentricis confertissimis et nonnullis distantioribus incrassatis tecta; lunula et area elongatis, excavatis, angustis; cardine dentibus cardinalibus et lateralibus bene distinctis instructo; margine interno plus minusve distincte crenulato.

Height of shell	:	its length...	...	...	...	0.75-0.81
Thickness	„	:	„	...	...	0.36-0.50

This species has very much the form of the type species of *Myrtea*, *Luc. spinifera*, Mont., and the hinge is also quite similar, so that there can be no doubt as to the sub-generic determination of the species. It is always longer than high, the lunular margin slopes very precipitously and is slightly concave, the upper or areal margin nearly straight or slightly convex, the edges being rather sharpened and somewhat prominent; both lunula and area are deeply excavated and elongated; the surface is covered with numerous striæ of growth, near the apex all are stronger, but further on only a few are more prominent at certain distances, and separated by deep sulci. In some of the specimens I have not been able to observe any crenulation of the internal margin, in others it is, however, distinct.

Localities.—Parally (one specimen from a dark colored earthy limestone); Andoor (two specimens in a grey conglomeratic sandstone); Olapaudy (two specimens in a light brown oolitic rock).

Formations.—Ootatoor, Trichinopoly, and Arrialoor groups.

6. LUCINA [MYRTEA] DENTIGERA, *Stoliczka*, Pl. XV, Figs. 6-8.

L. [Myrt.] testa sub-quadrangulari, crassiuscula, tumida, margine lunulari concavo, areali rectiusculo; lunula lata, ovate elongata, profunda, area paulo excavata, angustiore; superficie concentrice lamellose confertim striata, margine interno crasse dentato.

Height of shell	about equal to its length.				
Thickness of same	:	its length	...	...	0.71

The more regularly quadrangular and at the same time more tumid form readily distinguish this species from the previous one. The surface is covered with concentric, sharp, equal lamellar striæ; the inner margin is particularly in some

specimens very strongly dentated and thickened. I have only imperfectly seen the hinge-teeth, the cardinals appear to be regular, the posterior are very much smaller than the anterior; on each side there is a long lateral rim parallel to the margin, as in other *Lucinæ*, but whether it terminates with a special lateral tooth I have not been able to trace out.

Localities.—Olapaudy and west of Arrialoor, in a brownish and grey conglomeratic sandstone.

Formation.—Arrialoor group.

XXIV. *Family*,—*UNGULINIDÆ*.

The animals of the genera referable to this family agree in form with those of the *LUCINIDÆ*, but they have the mantle margins much more united below, leaving in front only a comparatively small pedal opening, the siphonal orifice is also single; the gills are of moderate size and consist of two elongated plumes on each side; the foot is elongated, hollow inside, generally vermiform, or somewhat geniculate, but always much shorter than in the previous family; the mouth is of moderate size, and the palpi, four in number, well developed.

The shells are oval or roundish, rather thin, with the internal surface always of a peculiar silky or pearly appearance and mostly quite smooth; the hinge usually has two small cardinal teeth in each valve, the laterals are always wanting; the muscular scars are oval, or elongately oval, sub-equal, the anterior being rarely much longer than the posterior; pallial line entire, sometimes truncate posteriorly and generally faint; ligament external or sub-internal.

I shall refer to this family the following seven genera: *Hippagus*, *Scacchia*, *Ungulina*, *Cyrenoida* (= *Cyrenella*), *Felania*, *Mysia* (= *Diplodonta*), and *Psathura*. Deshayes, and many other conchologists who accept that celebrated author's views, class several of the above-named genera in the *LUCINIDÆ*, admitting the difficulty which exists in the classification of the fossil species. There can be no question that all those genera quoted exhibit a very marked relation to the *LUCINIDÆ*; but when we look at the important differences which I have pointed out in the anatomy of the animals, namely, the small size of the foot, the presence of well developed labial palps, the single posterior siphonal orifice, and also the regular want of lateral teeth in the shells, their thin and silky internal structure, the form of the muscular impressions, &c., we must regard the present family, in the manner introduced by H. and A. Adams in their "Genera," as a small natural group of shells.

In their geological history the *UNGULINIDÆ* also differ somewhat from the *LUCINIDÆ*. There are some forms known already in palæozoic (Silurian and Carboniferous) rocks, very strongly resembling in external shape *Ungulina*, and which have been described under that generic name; but sufficiently authenticated species of the family are as yet only on record from cretaceous and younger deposits, their number slightly increasing up to the present date. On the whole, these shells are always rare.

1. *Hippagus*, Lea, 1833, (Contrib. to Geol., p. 72). Shell ovate, higher than long, tumid, with prominent, attenuated, incurved beaks, of moderate thickness, internal and external superficial layers of a silky appearance; hinge edentulous, with a simple insinuation or a slight notch; ligamental furrow sub-internal, lunula not excavated, muscular impressions ovate, marginal; type, *H. isocardioides*, Lea, from tertiary beds of Alabama.

I have already (p. 225) noticed that this shell cannot be classed with *Verticordia* and others, as has been done by most authors. The form and silky structure of the internal layer of the shell indicate a close relation to *Ungulina* and *Mysia* in the same manner, as *Cryptodon* or *Loripes* is allied to typical *Lucina*. Besides the type species I only know a second one, *H. Æmilianus*, which occurs in the South Indian cretaceous deposits, and is very closely allied to the American form.

2. *Scacchia*, Philippi, 1844. Shell sub-orbicular, thin, muscular impressions roundly ovate, sub-equal, left valve with one, right valve with two small cardinal teeth, lateral teeth only indicated by very slightly raised edges of the inner anterior and posterior margins near the beaks. Type, *S. elliptica*, Scacchi, from the Mediterranean; the only other species known is *S. ovata*, Phil., which is doubtfully identified with the Crag *Kellia cycladia* of Wood.

3. *Ungulina*, Daudin, 1802. Shell sub-orbicular, covered with a thick wrinkled epidermis, hinge with two diverging cardinal teeth in each valve, ligament sub-internal; muscular impression narrow, elongated. Type, *U. rubra*, Roissy, is said to be an estuarine species from the Senegal. H. and A. Adams mention that a few species live in the Mediterranean, but Weinkauff in his "Conchil. d. Mittelmeeres" does not notice any.

Shells which in external form resemble *Ungulina* as well as *Scacchia* are found already in the Trias and Lias, and they are referrible to either one or the other genus; some have been described as *Ungulina*, but it is more probable that they belong to *Scacchia*, as this is a purely marine form and has the ligament external.

4. *Cyrenoida*, Joannis, 1835, (*Cyrenella*,* Desh., 1835). Shell roundly sub-quadrangular, beaks small, almost anterior, covered with a thick epidermis; muscular impressions large, ovate; ligament external, very long; hinge with three cardinal teeth in each valve; in the right the posterior is very small and sometimes almost obsolete; the middle is strongest, sub-triangular and bifid, the anterior is thin, lamelliform; these two last teeth are directed anteriorly; the left valve has one large lamelliform anterior cardinal, directed forward, and two very small posterior ones, the last being, as in the other valve, represented only by a slight thickening of the frontal edge of the fulcrum. Type, *C. Dupontii*, Joan., from the Senegal.

Philippi (Handb., p. 316,) says that there is a pallial sinus present, which I could not observe in the above mentioned type species. H. and A. Adams proposed

* This name was published in the same year as that of *Cyrenoida*, but it is printed on a subsequent page of the same Volume, and has, therefore, no doubt been handed over somewhat later for publication.

a special family for it which they place near to the *CYRENIDÆ*, but the form of the hinge, that of the muscular impressions, and the peculiar silky structure of the internal shell, possessing at the same time a certain amount of roughness, so characteristic for the *UNGULINIDÆ* leaves, I think, very little doubt that the true ally of *Cyrenoida* is *Mysia* (= *Diplodonta*), and not *Cyrena*. With the last it has actually only the outer rough epidermis in common, but this also occurs in *Ungulina*, as well as in most of the brackish-water or estuary shells.

5. *Felania*, Recluz, 1851. Shell roundish, compressed, or sometimes ovately elongated, thin, covered with a smooth, finely striated shining epidermis, hinge with two diverging cardinal teeth in each valve, the anterior in the left and the posterior in the right being bifid; muscular impressions large, oval; pallial line truncate posteriorly or with a very short sinus. Type, *Fel. diaphana*, Gmel., (le Falun of Adanson,—*Lucina Adansonii*, Reeve,) from the Senegal. Reeve in his monograph of *Lucina* describes several other species chiefly from Central America. A few species also occur in the estuaries along the coast of the Bay of Bengal; they appear to be as yet undescribed. In two of our eastern species I have not observed any posterior sinus, the pallial impression being distinctly entire, slightly truncate posteriorly; the muscular scars are marginal, elongated, and flexuous.

6. *Mysia*, Leach, 1827, [? 1820] (= *Diplodonta*, Bronn, 1831). Shell sub-orbicular or roundly quadrangular, more or less tumid, concentrically striated, hinge with two cardinal teeth in each valve, the anterior in the left and the posterior in the right being bifid, but the teeth of the left are generally smaller and the anterior has sometimes the front half obsolete; internal hinge margins in front and behind the beaks usually slightly channelled, muscular impressions elongated, sub-marginal, pallial line entire; type, *Mysia rotundata*, Mont.

It having been ascertained that the *Tellina rotundata* of Montagu was selected by Leach as the type of his genus, there is no reasonable ground to be given upon which the priority of Bronn's *Diplodonta* could be based. I am not aware that Leach's name was published in 1820, but it certainly was used in 1827 by Brown in his Conchol. Illustrations for the type species *M. rotundata*, and as this shell must have at that time been well known through the researches of Montagu, Dillwyn, Wood, Turton, and others, its generic priority against that of *Diplodonta* cannot be ignored. *Mysia* differs from *Felania* by a somewhat more solid structure of the shell, want of an olivaceous epidermis, perfectly entire pallial impression, and somewhat more elongated muscular scars. Species of *Mysia* are rare in cretaceous deposits, and their occurrence in still older rocks is doubtful.

7. *Psathura*, Desh., 1860, (Paris foss., 2nd edit., i, p. 478). Shell elongately ovate, thin, resembling *Clementia*, each valve with two diverging cardinal teeth, those in the right are both bifid, in the left only the anterior is bifid; muscular impressions narrow, marginal, elongated, pallial line entire. Type, *Ps. fragilis*, Desh., from eocene beds of the Paris basin.

LIST OF CRETACEOUS SPECIES.

Pictet and Campiche, Pal. Suisse., 4^{me} ser., 3^{me} part., p. 296, only record the following two species under the name *Diplodonta* :—

1-2.—*Mysia Urganensis*, P. and C., and *M. gurgitis*, P. and R.; the first is from the Urganien, the second from Gault-beds.

In the list of the species of *Lucina*, I have particularly noticed the following as externally resembling *Mysia* :—*L. globiformis*, Leym., *L. ? solidula*, and *L. Turonensis*; the hinge-teeth of these species should be carefully examined.

3-5.—*Mysia gibbosa*, Gabb, (Jour. A. N. Sc., pl. iv; p. 302), *M. parilis*, Con., (ibid. p. 278), and ? *M. polita*, Gabb, (Pal. Calif., i, p. 178,) are noticed from North America.

6.—*Hippagus Æmilianus* is the only species which represents this family in the South Indian cretaceous rocks.

I may also notice that *Cyprimeria obesa*, which d'Orbigny described as a *Lucina* (vide p. 180), has the external form and the hinge-teeth somewhat resembling those of a *Psathura*, but in the only right valve which I have seen the anterior bifid cardinal tooth is much more oblique than in Deshayes' typical *Psathura*. However, better preserved specimens of both valves would deserve a careful comparison regarding this point.

HIPPIAGUS, Lea, 1833, (see p. 260).

1. HIPPIAGUS ÆMILIANUS, Stoliczka, Pl. XIV, Fig. 6.

H. testa verticaliter ovali, multo altiore quam longa, valde inflata, umbonibus obtusiusculis, prominulis, incurvis, approximatis instructa, crassiuscula, sub-vitrea, in superficie striis minutissimis sub-lamellosis concentricis ac alteris sub-obsoletis radiantibus ornata; regione lunulari et areali haud circumscriptis; cardine edentulo obsolete insinuato; margine interno continuo, levi.

Height of shell	:	its length	...	...	...	1.44
Thickness (of both valves)	:	"	...	...	...	1.26

I have already noticed that this species most closely resembles the eocene *H. isocardioides*, Lea, the type of the genus, which is only a little higher and apparently somewhat shorter than our fossil. The shell itself is of considerable thickness, and of a silky appearance, as commonly seen in recent species of *Mysia*; the surface is covered with numerous striæ of growth, some of which are stronger than others, and towards the margin are intersected by deeper furrows; besides that there are numerous fine short interrupted radiating striæ perceptible.

Locality.—Strípermatúr in whitish soft sandstone, in which a few specimens only were discovered by the lamented Ch. Æmilius Oldham, late Deputy Superintendent of the Madras party of the Geological Survey of India.

Formation.—Arriallor group.

XXV. Family,—*ERYCINIDÆ*.

The animals have the mantle margins below open, either entire or provided with filaments, and often greatly extensible beyond the edges of the shell; in front the margins form a more or less distinct open fold which represents the inhalant siphon, the exhalant siphon is situated posteriorly, and prolonged into a more or less spacious tube; the foot is large, generally with a grooved and expansible sole, often bent upwards and posteriorly provided with a small byssus; there is a pair of gills and one pair of palpi on either side.

The shells are of small size, oval, or sub-triangular, thin, equivalve, closed, generally inequilateral, with the surface smooth or finely ornamented and often covered with a polished epidermis; the hinge is provided with strongly diverging cardinal and sometimes also with lateral teeth; the cartilage is internal, situated between the teeth; two muscular impressions; pallial line entire.

The *ERYCINIDÆ* form a very natural group of small shells, mostly living on sandy or gravelly ground at considerable depth of sea; their geographical distribution is general. Almost a larger number is known from northern than from other seas, but, the tropical regions having as yet been only very little explored with the dredge, it is difficult to form a correct conclusion on the distribution of the family.

The present number of recent species is scarcely as large as that known from the Paris basin alone, and if other eocene deposits are equally, or nearly so, rich, it would certainly appear that the family then possessed its greatest development. From cretaceous rocks only one species has been recorded; others do not appear to be satisfactorily determined, and those noticed from older formations under the names of *Erycina*, and others, are perfectly unreliable.

The genera to be placed in the present family are *Erycina* (= *Kellia*), *Erycinella*, *Spaniodon*, *Montacuta*, *Tellinmya*, *Kelliella*, *Lasæa* (= *Poronia*), *Lepton*, *Pristiphora*, *Bornia*, *Pythina*, *Cyamium*, *Hindsiella*, *Thecodonta*. H. and A. Adams class the genera which among those just noted occur recent in two families, separating *Lepton* from *Erycina* as types, but I do not think that the slight prolongation of the mantle and its marginal filaments are sufficient to justify such a separation.

1. *Erycina*, Lam., 1804, (*Kellia*, Turton, 1822, *Chironia*, Desh., 1839). Shell oval, generally somewhat elongated, sub-equivalve, moderately inflated, concentrically striated, or with more or less distinct radiating ribs; hinge with two widely diverging, large, often grooved or divided cardinal* teeth, sometimes there is a minute tooth immediately under the beak, but more often it is obsolete in both, or, at least, in the right valve. Cartilage situated in an internal groove, extending from the beak posteriorly and situated in front of the posterior tooth; type, *E. pellucida*, Lam., from eocene beds of the Paris basin.

* In some of the species the posterior tooth is rather remote, but it always originates near the beak, and should, therefore, be more properly called a cardinal than a lateral tooth, under which name it is generally quoted in conchological works.

There is no doubt that Lamarck, when he first proposed his genus *Erycina*, also referred to it species which have been afterwards shown not to belong to it. The greatest objection made against Lamarck's name is the association of some *Syndosmyæ* with it, both genera agreeing in several important characters. At the same time there can, I believe, be not the least doubt that Lamarck has taken his original characteristic from one of the typical species which he described, for he mentions nothing of the existence of a pallial sinus. This character was afterwards added in the subsequent edition of the An. s. Vert. Deshayes, therefore, justly says in his second edition of the Paris fossils that Lamarck's original characteristic was an excellent one; and certainly the description of the hinge Lamarck gave could not be misunderstood for anything else but an *Erycina*. Lamarck could not have taken his characteristic from any living species. Weinkauff (Conch. d. Mittelmeeres, 1867, p. 180,) discussed the propriety of the two names *Erycina* and *Kellia*, and says, that if the former is to be retained at all it should be restricted to the fossil species only, but where no essential differences exist, no generic distinctions can be made. *Chironia* which was proposed by Deshayes for the recent *Erycina Laperousii*, and which is adopted by Chenu in his Manuel, has been again identified by Deshayes with the present genus. It does not offer any distinctive characters from *Erycina*.

2. *Erycinella*, Conrad, 1838, (Mioc. foss., p. 74). Shell minute, oval, with slightly produced, obtuse beaks, inequilateral, surface with indistinct radiating lines; hinge in the left valve with two small inner and two large outer cardinal teeth, right valve with only two outer large teeth; cartilage apparently in an internal groove between the teeth, but it is not specially referred to in the type species *E. ovalis*, C., which is from miocene beds of Virginia. Conrad's characteristic is not very satisfactory, and (Am. Journ. Conch., v, 102,) he says that the oligocene *Woodia lævigata* from Söilingen (Dunker's Palæont., vi, 252, pl. 30, fig. 8,) is an *Erycinella*. If this be the case no cartilage would seem to be present, but only a single median cardinal tooth, and the outer cardinals should then be looked upon as laterals, in which case *Erycinella* should be transferred to the *ASTARTIDÆ* and placed near *Woodia*, if not identified with it.

3. *Spaniodon*, Reuss, 1867, (Sitzungb. Akad., Wien, lv, p. 134). Shell roundly sub-trigonal, with somewhat produced obtuse beaks, nearly equilateral; surface only concentrically striated; hinge with an anterior (sub-lunular) elongated cardinal tooth in each valve, in the right separated from the margin by a deep groove; cartilage in a pit situated below and a little posterior to the beaks; muscular impressions rather large, equal. Type, *Sp. nitidus*, Rss., from miocene beds near Wieliczka in Galicia.

4. *Montacuta*, Turton, 1819. Shell minute, oblong, inequilateral, radiately striated or obsoletely sulcated; hinge with two remote, diverging cardinal teeth in each valve, cartilage situated internally between them. Type, *M. sub-striata*, Mont. Thomson described a *M. Gouldi* from America (Am. Journ. Conch., iii, p. 33).

5. *Tellimya*, Brown, 1827. Shell oval, inequilateral, concentrically striated, hinge as in *Montacuta*, but the cartilage partially hardens to a solid ossicle; type, *T. bidentata*, Mont.

H. and A. Adams restrict the name *Montacuta* to Montagu's *Ligula substriata*, referring to certain differences in the organisation of the animal of this species as compared with Montagu's *Mya bidentata*. From the descriptions Jeffreys gives in his Brit. Conchology there seems to be, however, no essential difference between the animals of both, and that author consequently places them both in *Montacuta*. It certainly appears that the anterior expansion observed on the foot of *M. substriata* is not a constant form of it; but as the two species referred by H. and A. Adams to *Tellimya* (*T. bidentata* and *ferruginosa*) differ from the former by the want of radiating lines, and that of an ossicle, and also by their habitat, they may be kept separate.

6. *Kelliella*, Sars, 1868. This name occurs in the list of northern deep sea shells, published by Sars, and translated in Ann. Mag. Nat. Hist., 4th ser., vol. iii, p. 429. I am not aware that the characters have as yet been pointed out. The type species, *K. abyssicola*, Sars, is placed between *Astarte* and *Montacuta*.

7. *Lasæa*, Leach, 1827, (*Poronia*, Recluz, 1843). Shell oblong or roundish, usually somewhat inflated, very thin, concentrically finely striated; hinge with two large diverging cardinal teeth, and in the left valve with an additional minute hook-like tooth between the two; cartilage on a raised groove on the shorter side of the shell; type, *Cardium rubrum*, Mont. Brown having proposed in 1827 the name *Lasæa* for the well known species of Montagu, and having used the same again in 1833 as a generic determination for the same species, the genus must be adopted in preference to Recluz' *Poronia*.

It seems probable that this genus is largely represented in a fossil state, and that a number of the *Corbulæ* with thin shells will have to be referred to it.

8. *Lepton*, Turton, 1822. Shell oval or sub-orbicular, slightly gaping at both ends, smooth or scrobiculate on the surface; hinge with two very widely diverging and elongated laminar teeth, between which there is sometimes one small cardinal tooth in the right and one or two in the left valve; but sometimes these small teeth are obsolete; cartilage situated in a groove in front of the posterior large tooth. Type, *Lept. squamosum*, Mont., sp. The hinge of *Lepton* is, as Deshayes remarks, quite similar to that of *Erycina*, except that the outer laminar teeth are larger and the shell thinner; the animals of both differ greatly by the prolongation of the anterior and posterior tube in the first named genus, and also by the disc-like foot.

9. *Pristiphora*, Carp., 1866, (Proc. Calif. Acad., p. 210). Shell oval, with two diverging teeth in each valve, the anterior being conspicuously shorter than the posterior, sulcated near the beaks, ligament situated in a groove between them; type, *P. oblonga*, Carp., from San Diego.

10. *Bornia*, Philippi, 1836, (Enum. Moll. Sicil., i, p. 13). Shell elongately oval, with slightly projecting beaks, almost equilateral, surface finely concentrically

striated; hinge with three teeth in the left valve, two small anterior and one somewhat remote and elongated posterior, right valve with only two diverging elongated cardinal teeth; cartilage situated in a groove in front of the posterior teeth; muscular impressions faintly marked; type, *B. corbuloides*, Phil., occurs recent in the Mediterranean and the Atlantic, and fossil in miocene beds of Italy and the Vienna basin.

Chenu figures the animal of this species as *Erycina Geoffroyi*, (Man., ii, p. 124), which shows that the prolonged foot and the mantle fold are quite different from either *Lepton* or *Lasæa*.

11. *Pythina*, Hinds, 1844. Shell oval or roundish, with radiating or divaricate striæ or sulci on the surface; right valve with two, left with three, cardinal teeth, the outer one diverging and elongated, cartilage small in front of the posterior teeth; type, *P. Deshayesiana*, H. The hinge of this genus is exactly the same as that of *Bornia*, from which *Pythina* only differs by its peculiar divaricate striation.

12. *Cyamium*, Philippi, 1845. Shell oblong, inequilateral, slightly gaping or closed; hinge with two sub-anterior cardinal teeth in each valve, the anterior being produced and lamellar; cartilage internal, situated in a groove behind the teeth, and ligament external, supported by distinct fulera; pallial line truncate behind; type, *C. antarcticum*.

H. and A. Adams (Genera ii, p. 651,) suggest that *Turtonia* with the type *T. minuta*, Fab., should be kept distinct from *Cyamium* proper, but Jeffreys (Brit. Conch., ii, 257,) states that he carefully examined numerous specimens of both species and believes them to belong to the same genus. Perfect specimens of *C. antarcticum*, he says, are closed at both ends.

13. *Hindsia*, Stol., 1870, (*Hindsia*, Desh., 1860, Paris foss., 2nd ed., i, p. 693—non *Hindsia*, H. and A. Adams, 1850). Shell elongately sub-triangular, nearly equivalve, with the lower margin insinuated, hinge with one or two (generally one in the right, two in the left) minute cardinal teeth in each valve; ligament external, supported by thin fulera; muscular impressions narrow, elongated, pallial line rather broad, simple; type, *Modiola arcuata*, DeFr., from the eocene of the Paris basin.

Deshayes alludes to the close relation of this genus to *Pythina*; it also recalls the form of *Cyamium*, which has an external ligament, and the hinge-teeth are in structure somewhat allied to *Lasæa*; but as there is apparently no cartilage present, it appears probable that the genus could be more correctly classed next to *Modiolarca*, Gray, in the family *GLOSSIDÆ* (vide p. 184).

14. *Thecodonta*, A. Ad., 1864, (Ann. Mag. Nat. Hist., xiii, p. 308). Shell oblong, very inequilateral, the anterior part being shorter than the posterior, concentrically sulcated; hinge in the left valve with two diverging cardinal teeth with a cup-like projecting fold between them, a single posterior lateral tooth present; pallial line single and radiately grooved, anterior muscular scar triangular, posterior oval; type, *Th. Sieboldi*, A. Ad., from the China seas. The right valve of this remarkable shell, which recalls the form of *Heterocardia*, has not as yet been seen,

and the position of the cartilage is not known. A. Adams believes that the genus belongs to the *LASÆIDÆ*, = *ERYCINIDÆ*.

The only cretaceous species known is *Erycina* (*Kellia*) *cretacea*, Con., Journ. Acad. N. Sc., Ph., iv, p. 280, pl. 46, fig. 19.

XXVI. Family,—*GALEOMMIDÆ*.

The form of the animals is elongately ovate or sub-orbicular; they possess a thick, united mantle with a comparatively small anterior and posterior opening, the first consisting of a simple mantle-fold above the gape for the foot, the second of a short exhalant tube; the external edges of the mantle project beyond the margins of the shell; there are as usually two pairs of gills and two of labial palps; the foot is elongated and byssiferous.

The shells are small, very thin, always more or less gaping, hinge very small, with obsolete or nearly obsolete teeth and an internal cartilage.

To this family belong the following five genera, *Libratula*, *Scintilla*, *Passya*, *Galeomma*, and *Thyreopsis*. They form a natural group by themselves, differing from the *ERYCINIDÆ* by the very thin gaping valves and by having the mantle margins much more united than the animals of the last named family. About 50 recent species have been described, but only a few tertiary, and none from mesozoic or older deposits.

1. *Libratula*, Pease, 1865, (Proc. Zool. Soc., Lond., p. 512). Semi-lunar, much compressed, (like a *Placuna*), slightly gaping all round, cardinal margin crenulated, cartilage median, internal; type, *L. plana*, from the Pacific islands, found on coral.

2. *Scintilla*, Desh., 1855, (Proc. Zool. Soc., Lond., p. 171, and Paris foss., 2nd ed., i, p. 697). Oval, equilateral, sometimes slightly gaping, hinge not emarginated in the middle, with one uncinatè cardinal tooth in the right and two in the left valve, a posterior lateral tooth single in the right and double in the left valve, anterior lateral margin internally grooved in both valves; cartilage in a groove in front of the posterior lateral teeth; type, *Sc. Philippinarum*, Desh.

Deshayes describes no less than thirty-six recent species from Cuming's collection, some of them rather difficult to be made out again. A few additions to that number have been made since by Sowerby and others. Two species are also noted by Deshayes from the Paris basin.

3. *Passya*, Desh., 1860, (Paris foss., 2nd ed., i, p. 688). Elongated, sub-triangular, somewhat irregularly rounded in front, produced behind, very inequilateral, with an almost straight and very long upper margin, gaping at both ends, hinge sub-anterior, with a small tubercular tooth in each valve; ligament internal? muscular scars very small, remote; type, *P. Eugeniei*, Desh., from eocene beds of the Paris basin. In the single species as yet known the position of the cartilage has not been observed, but in general character of structure, and especially in the peculiar gaping, the shell resembles the next genus.

4. *Galeomma*, Turton, 1825. Elongately oval, sub-equilateral, with a large gape in front, somewhat pearly, with decussate striæ on the surface; cartilage internal under the beaks, with no teeth in the hinge in the type species, *G. Turtoni*, Sowerby (= ? *Tellina aperta*, Renier). Deshayes (Proc. Zool. Soc., Lond., 1855, p. 167), however, describes a great number of species which he refers to *Galeomma*, though they have distinct cardinal teeth or rather, as he says, an articulated hinge. Whether these have to be separated in a distinct genus, as appears probable, or whether the characters of *Galeomma* have to be changed in so far as the hinge-teeth were sometimes obsolete and at other times developed, can only be determined by a re-examination of the materials. Deshayes considers the species with hinge-teeth as a mere section of *Galeomma*.

5. *Thyreopsis*, H. Ad., 1868, (Proc. Zool. Soc., Lond., p. 14). Shell resembling *Galeomma*, nearly equilateral, sub-triangular, beaks slightly tumescent and with the whole of the ventral margins widely gaping; type, *Th. coraliophaga*, H. Ad., from Mauritius. I have received from Bombay through the Rev. Mr. Fairbank an apparently new species of the same genus. The specimens do not show any siphons externally, but these may have been retracted before the animals were placed in spirit. I shall take an early opportunity to note their anatomical peculiarities.

XXVII. Family,—*SOLEMYIDÆ*.

The animal of *Solemya* is characterized by its elongated form, a wide anterior gape for the protrusion of the foot, reaching to near or beyond the middle of the ventral side; a single posterior exhalant short siphon, a pair of thick fleshy gills on either side, and four narrow, falciform palps at the mouth; the foot is large, deeply grooved, or excavated below, expansible, and provided with a fringed edge.

The shell is peculiar by its elongated, solenoid form, gaping valves which are of a thin structure, nearly obsolete hinge-teeth, strong ligament, being partially internal and partially extending over the hinge region, and by an entire pallial line.

According to these general characters of the animal and shell, the genus *Solemya* undoubtedly exhibits the greatest relation to *Galeomma*, next to which it must naturally be classified.

Recluz, in his account of the anatomy of *Solemya* (Journ. de Conch., 1862, vol. x, p. 110,) enters in detail into its comparison with that of *Solen*, though he does not add many new facts beyond what we already find introduced into conchological works. He states that there are two openings posteriorly, the one, upper or exhalant, probably prolonged into a short siphon, the other is closed by a lamina. Is it then an opening at all, corresponding to the inhalant or branchial siphon, or is it not? It is impossible to answer the question from Recluz's account. Comparing the animal of *Solemya* with that of *Galeomma*, I rather think it probable that there is no other but the exhalant opening.

There are only five recent species of *Solemya* known from the present seas; fossil species, however, sparingly occur from the oldest formation upwards. I have here associated with this genus a great number of fossil, mostly palæozoic

forms, several of which at the first glance certainly do not appear to have much in common with *Solemya*, but they are still less related to any other group of recent or fossil shells. Most of them are very unsatisfactorily characterized, and although I have recorded them here as independent genera, I have done so more with the view of exposing this insufficiency and drawing the attention of palæontologists to the gaps which have to be filled up, than with the intention of supplying characters of genera by which one could be distinguished from the other. The genera which I have enumerated here are *Cleidophorus*, *Pyrenomæus*, *Sanguinolites*, *Leptodomus*, *Orthonota*, *Anodontopsis*, *Sedgwickia*, *Dolabra*, *Grammysia*, and *Solemya*.

From what I have already stated it is clear that I cannot well account for the classification of these various forms. All, so far as known, agree in the solenoid or elongately oval inequilateral form, thin shell, and obsolete hinge-teeth. The difficulty is to find out in such fossil forms, as *Sanguinolites* or *Orthonota*, which side is the anterior and which the posterior. Palæontologists are invariably accustomed to regard the longer side as the posterior; the opposite is, however, certainly the case in *Solemya*, and if this be also the case in the two last mentioned genera, they could not be better classified in any other family than in this. The remainder of the genera here correlated are more or less allied in form to *Solemya*, and they may fairly be taken as indicating passages from this family to the *ASTARTIDÆ* and *CRASSATELLIDÆ*. Nothing but a very careful re-examination of all the palæozoic forms can lead to a satisfactory settlement of the present controversies to be met with in the various palæontological monographs.

1. *Cleidophorus*, Hall, 1847, (Pal. of New York, i, p. 300). Shell elongated, inequilateral, beaks small, sub-anterior, with a vertical rib in front of the beaks and another parallel to the upper straight margin; hinge-teeth none, or (according to M^cCoy) sometimes with a "small cardinal tooth behind the beak;" type, *Cl. planulatus*, Con., sp., from silurian beds of America and Europe.

M^cCoy, who writes (Brit. Palæoz. foss., p. 273,) the name of the genus *Clidophorus*, says that he finds from the examination of authentic specimens King's *Pleurophorus* to be identical with *Cleidophorus*; but unless King's figure of the interior of both valves is shown to be very erroneous, such an identification cannot be admitted.

2. *Pyrenomæus*, Hall, 1852, (Pal. New York, ii, p. 87). Elongated, inequilateral, anteriorly rounded, posteriorly attenuated and produced, concentrically striato-sulcated on the surface; beaks tumescent, anterior muscular impression deep, sub-anterior, (posterior unknown); hinge apparently without teeth; type, *P. cuneatus*, Hall, from the so-called Clinton group (Middle Silurian) of North America. If this genus is to be accepted at all, some of the species described by M^cCoy under the name of *Axinus* must be referred to it.

3. *Sanguinolites*, M^cCoy, 1844, (Carb. foss., Ireland, p. 47, and Brit. Palæoz. foss., p. 276). Very elongated, with sub-parallel upper and lower margins, rounded anteriorly, obliquely truncate posteriorly, with an oblique prominent ridge from the beaks to the postero-inferior margin, very inequilateral, beaks slightly prominent,

Solenyridæ. Must be a wonderful conglomeration according to this arrangement. *Cleidophorus* has as is now known, a small hinge like *Orthonota*, *Sanguinolites*, and the other genera mentioned above, do belong to the same families.

close together, sub-anterior; anterior muscular impression oval, distinct, with a small groove above it, and both posteriorly bounded by a prominent ridge, posterior muscular scar faint; cardinal margin internally thickened the whole length, probably for the support of a ligament; surface concentrically (or radiately? sometimes partially) striated or sulcated; type, *S. discors*, M^cCoy. Only palæozoic species are referred to the genus; some of them are in external form almost identical with *Pharella*, and it as yet remains to be shown whether there are in *Sanguinolites* any hinge-teeth present or not. In the Brit. Pal. foss., (p. 276), M^cCoy considers this genus apparently identical with King's *Allorisma*, stating that King "supposed them to be sinupallial, which certainly is not the case in the palæozoic shells," &c. We can only say again that unless King's statement and apparently correctly executed figures are disproved, the identification of the two genera must be set aside as inadmissible.

4. *Leptodomus*, M^cCoy, 1844, (Carb. foss., Ireland, p. 66, and Brit. Palæoz. foss., p. 277). Shell oblong, somewhat trapezoid, tumid, very thin, anteriorly rounded, beaks sub-anterior, posteriorly sub-truncate and gaping, concentrically sulcated; beaks incurved with a somewhat excavated lunule below; hinge without teeth, the posterior hinge-line more or less straight, muscular and pallial impressions faint; type, *L. fragilis*, M^cCoy. The species are all palæozoic; those with a median sulcus extending from the beaks to the ventral edge seem to be more correctly referable to *Grammysia*; the typical forms greatly resemble some *Trapezia* (= *Cypricardia*), but are readily distinguished from them by their thin shells.

5. *Orthonota*, Conrad, 1841, (1827?). Shell narrow, like a *Pharella*, with sub-parallel upper and lower margins, very inequilateral, the beaks being sub-anterior and tumescent, lunula in front (?) of the beaks somewhat excavated, very thin, surface posteriorly generally undulately striated, hinge apparently without teeth. Conrad (Am. Journ. Conch., 1866, ii, p. 103,) says that the type of this genus is *O. undulata*, Con., and quotes *Sanguinolites anguliferus* and *iridinoides* of M^cCoy among the European representants of the genus. Since the name was introduced, there appear to have been several other species referred to it with a crenulated or toothed hinge-line, and which seem to be identical with the shells called by King *Bakevellia*.

6. *Anodontopsis*, M^cCoy, 1851, (Ann. Mag. Nat. Hist., vii, p. 53, and Brit. Palæoz. rocks and foss., p. 270). Shell rather compressed, sub-trigonal or trapezoid, anteriorly generally somewhat narrowly rounded, posteriorly obliquely truncate, hinge rectilinear, shorter than the length of the shell, with an internal posterior marginal rib, double in the right valve, and a second shorter rib in front of the beaks; a small cardinal tooth is said to be occasionally present below the beaks; muscular scars ovate, the posterior larger and stronger than the anterior; pallial line entire; type, *A. angustifrons*, M^cCoy. Salter suggested for *A. securiformis*, M^cCoy, and allied forms, the name *Pseudaxinus*.

7. *Sedgwickia*, M^cCoy, 1844, (Carb. foss. of Ireland, p. 61). Elongated, inequilateral, anteriorly rounded and shorter, posteriorly sub-truncated, moderately tumid, with incurved beaks, anterior half of the surface ornamented with con-

centric sulcation, becoming obsolete posteriorly, hinge edentulous; type, *S. attenuata*, M^cCoy, from carboniferous rocks. The peculiar ornamentation is almost the only character by which the species referred to this genus can be distinguished from some species of *Leptodomus* and *Pyrenomæus*; it seems rather doubtful that there really exists a generic distinction between all these forms.

8. *Dolabra*, M^cCoy, 1844, (Carb. foss. of Ireland, p. 64, and Brit. Palæoz. rocks and foss., p. 269). Shell ovate or trapezoid, gibbose, with a more or less straight hinge-margin, inequilateral, inequivalve, the left valve being larger than the right, hinge posteriorly with an elongated tooth, sometimes bifid in the left valve; type, *D. corrugata*, M^cCoy. Whether those species which have a crenulated or toothed hinge-margin belong to the above genus, or not, remains doubtful; there seems to be here a similar mixture of species as in *Orthonota*.

9. *Grammysia*, Verneuil, 1847, (Bull. Soc. Géol., France, iv, p. 696; M^cCoy, Brit. Palæoz. rocks and foss., p. 280; Sandberger, Rhein. Schichtensyst., p. 264). Shell elongated, sub-equilateral, with prominent and incurved beaks and an excavated lunule in front of them, one or two sulci extend from the beaks to the middle of the inferior margin; hinge-line straight, much thickened, without teeth, ligament situated in a groove behind the beaks, muscular scars two, anterior nearly round, posterior emarginated above, pallial line entire, but truncate posteriorly; type, *G. pes-anseris*, Zeil. and Wirtgen, from the palæozoic rocks of the Rhenish provinces.

In external form some species of *Grammysia* greatly recall *Tridacna*, but others are closely allied to *Sanguinolites* and *Leptodomus*.

10. *Solemya*, Lam., 1818. Shell elongated, oblong, thin, moderately compressed, inequilateral, the posterior side being much shorter than the anterior, thin, covered with a shining epidermis, which extends beyond the margins; hinge with one elongated cardinal tooth in each valve, and a posterior internal rib, to which a portion of the ligament is attached, spreading out near the beak, while the larger portion remains external; pallial line entire, marginal; type, *S. australis*, Lam. There are only a few recent species known. One species (new ?) occurs at the Nicobars and in the Bay of Bengal. Fossil species are known from all formations down to the Silurian; at least there seem to be no valid external characters by which the fossil forms could be distinguished from the recent ones. King (Perm. foss. of England, p. 177,) called some Permian species *Janeia*, but upon a close comparison of these with the recent type species he again cancelled the name (vide ibidem, p. 246). Verneuil's *Solemya biarmica* appears to have been taken as the type of *Janeia*. I have no typical specimens to compare, but if the figure 4, pl. xix, in Geol. of Russia belongs to the same species, and if that figure of the cast is correct, it would appear to be without the elongated cardinal tooth, and consequently distinct from *Solemya*, but it may be identical with *Orthonota*.

The only two cretaceous species of *Solemya* are from North America, *S. subplicata*, M. and H., Proc. Acad. N. Sc., Phil., viii, p. 283, and *S. ventricosa*, Conrad, (Smith. Misc. Coll., No. 200, p. 5); the last is from Conrad's so called lower eocene beds.

XXVIII. *Family*,—*ASTARTIDÆ*.

Animal elongately ovate or sub-trigonal, with the mantle margins thickened, disunited below in their entire extent, posteriorly with a single opening; foot laterally more or less compressed and sharpened below, pointed at the end, and in young specimens sometimes with a byssal groove at the posterior base; palpi two pairs, generally narrow, sub-triangular, striated; gills one pair on each side, the leaflets being unequal, the interior mostly larger, or sub-equal, anteriorly rounded, posteriorly pointed and more or less produced.

The shells are thick, solid, equivalve, with the cardinal teeth always well developed, 2-3 in each valve; lateral teeth are sometimes present on one or on both sides, ligament always external, strong; muscular scars ovate, the anterior usually with a small deep superimposed pit, produced by the retractile muscle of the foot; pallial line entire. All the species are marine.

The genera which have to be referred to the present family are very numerous, and the greater number of them is only found in a fossil state. Merely in order to facilitate the grouping of the different types, I shall here provisionally introduce two sub-families under the names *ASTARTINÆ* and *CARDITINÆ*. Of the former the genus *Astarte* may be taken as the type; the shells included in the sub-family are distinguished by a sub-trigonal or roundly oval shape, and a smooth, concentrically striated or sulcated surface. The *CARDITINÆ*, with the typical genus *Cardita*, include shells of a roundly ovate or elongated form, always provided with radiating ribs or striæ. In the former sub-family I shall enumerate the following—*Megalomus*, *Pachydomus*, *Megalodon*, (sub-g. *Eu.*- *Neo.*- and *Pachy-megalodon*), *Astartila*, *Conchodon*, *Pachyrisma*, *Opis*, *Opisoma*, *Par-astarte*, *Cypricardinia*, *Anoplophora*, *Cardinia*, *Trigonodus*, *Euloxa*, *Astarte*, (sub-g. *Gonilia*), *Grotriania*, *Præconia*, *Gouldia*, *Alveinus*, *Goodallia*, *Lutetia*, *Mycromeris*, *Goodalliopsis*, and *Woodia*; to the latter will be referable *Matheria*, *Pleurophorus*, *Palæocardita*, *Pleuromeris*, *Miodon*, *Pteromeris*, *Cyclocardia*, *Venericardia*, *Cardita*, *Mytilicardia*, *Carditamera*. I have already observed that the arrangement of the two sub-families is to be considered only a provisional one.

The whole family, as it now stands, belongs decidedly more to the past epoch than to the present one. Our knowledge of the organisation of the animals of the few genera examined is as yet rather unsatisfactory, and moreover the different accounts are somewhat contradictory.

Taking notice of the anatomy of the animals of the Pelecypoda in a classificatory point of view, the number, position, and form of the siphons, or of the branchial and anal openings, has been considered as one of the most important characters. Of the *ASTARTINÆ* we know some of the animals of *Astarte* and of *Gouldia*, the only two recent genera—besides *Woodia*—of which I have met with the description of the animals. Forbes and Hanley, in their admirable History of British Mollusca, state that *Astarte* has two siphonal openings, and this statement appears to have been generally accepted. H. and A. Adams in their

"Genera" do not say anything on this point, but simply take the figure of *A. sulcata* from the Hist. of British Mollusca. Jeffreys in his British Conchology also follows in his account the same authors. I am not in a position to doubt this record of the anatomy of *A. sulcata*, but I have lately received from my friend G. Nevill two species, one apparently *A. semisulcata*, Leach, and the other most likely a variety of *A. sulcata*, Mont., from Greenland, both with the animals beautifully preserved. In both these species the animals have a strongly compressed, anteriorly pointed foot, a pair of narrow triangularly elongated palpi on each side of the mouth the edge of which is finely ciliated; it is situated just behind the anterior adductor muscle; the gills are unequal on either side, the outer leaflet being smaller, and both are pointed behind, reaching almost below the posterior adductor muscle with their terminations. The mantle is open below in its entire extent, and has behind a small opening in which terminates the anus, the rectum curving from above and being partially attached to the hinder side of the posterior adductor. Thus these two species decidedly have no siphons at all. The access of the water to the branchia is quite free below, and the single opening must be considered as the anal one. This corresponds with the account which Philippi gives in his "Handbuch der Conchilologie," stating that the *ASTARTIDÆ* have no siphons. The next genus *Gouldia*, represented by the type species *Gouldia minima*, Mont., sp., is, however, perfectly well known to possess two very short or sessile fringed siphonal openings, very like those of *Cyprina* or *Corbicula*. The species is, therefore, generally referred to the genus *Circe*, Schum., and though in form it certainly appears much better to agree with *Astarte*, it shows also great similarity to some species of that sub-genus, such as *Circe divaricata* and others. Very probably this change in the classification has to be effected, and there would be no particular objection to having it carried out in my present account, if there was not another difficulty in the way which indeed it seems very difficult to understand.

Looking at the animals of *Venericardia* and that of *Cardita*, we find, so to say, a similar contradiction as the one noted between *Gouldia* and *Astarte*. Recluz (Journ. de Conch., 1862, x, p. 116,) says that *Venericardia* has only a simple mantle-fold or single opening, while *Cardita*, (*C. antiquata*), as well as *Mytilicardia*, are said to possess two distinct siphons.

I cannot say how far the accounts published regarding the anatomy of *Carditæ* and similar forms are correct, but I will note the result of my observation. I have recently examined well preserved specimens of *Cardita antiquata* (*bicolor*) sent to me by the Rev. Mr. Fairbank from Bombay. The animal has the whole mantle open below and in front, posteriorly there is only one spacious slit, in which the rectum terminates exactly as in *Astarte*; the gills are elongated, one pair on each side, the leaflets being rather unequal, pointed at the end, and extend to below the commissure, where the edge of the mantle is finely ciliated; the palpi are small, high, and regularly triangular; the foot large, compressed, pointed at the end, posteriorly with a byssal groove, and was folded over laterally

in the closed shell. Another species which I have examined is *Mytilicardia* (*Beguina*) *semi-orbiculata*, Linn., from the Nicobars. It has the mantle again open all round, with a rather large posterior anal opening; there are three large sub-equal leaflets of gills on either side; the mouth is large and the four palpi small, narrow, elongated; the foot small, compressed, with a very large byssal groove and strongly developed byssus below.

Thus this account of the animal of *Cardita* differs* considerably from that given by Recluz, but both the species agree in all essential characters with the anatomy I observed in *Astarte*, and I do not see, therefore, any sufficient reason as yet to alter the arrangement which I have here adopted in the classification of the various genera. We must, as I said, await further elucidation on this point through the examination of more species.

The *ASTARTIDÆ* are numerous through all the geological formations. A few like *Pachydomus* and *Astartila* are only represented in palæozoic times. During the middle mesozoic period the *ASTARTINÆ* were most varied in generic types and most numerous in species; after that time their number decreases, and at the present the recent *Astartes* are almost confined to the northern seas, while *Gouldia* is also tropical. On the other hand, the *CARDITINÆ* are mostly all tropical species; there are, at least, 80 known from present seas. They are also represented already in palæozoic beds, but their number remains comparatively small through all the succeeding epochs, though sensibly increasing, until in the eocene they reach a great development, but, I think, their number is somewhat smaller than that of the present time.

1. *Megalomus*, Hall, 1852, (Palæont. of New York, vol. ii, p. 343). Shell longitudinally oblong, moderately inflated, beaks anterior, incurved, tumescent, and considerably more thickened than the rest of the shell, which is rather solid; hinge with several short folds below the umbo; muscular impressions deep, rounded, the anterior smaller, and with two superimposed small impressions. Type, *M. Canadensis*, Hall, from silurian rocks.

The form of this shell somewhat resembles *Myoconcha*, but the thickness of the shell and the incurved beaks appear to indicate a greater relation to *Megalodon* than to that genus. I do not think that the typical species of *Megalomus* can be identified with *Cypricardites* of Conrad.

2. *Pachydomus*, Morris, 1845, (Strzelecki, New South Wales, p. 271; Dana in Expl. Exp. Geol., p. 692). Shell solid, inequilateral, and sub-triangularly elongated, posteriorly obliquely truncate, concentrically lamellated or striated, two deep sub-equal anterior muscular impressions, posterior large, but less excavated; hinge with one, or two (?) cardinal teeth; internal surface of shell rugose, ligament strong external; pallial impression thick, entire, but truncate posteriorly, being parallel to the posterior margin, or nearly so; type, *P. cuneatus*, Sow., from palæozoic rocks of New South Wales. The hinge-teeth of this genus are insuffi-

* Recluz says that there is only one gill on each side.

ciently known, and, therefore, the classification somewhat doubtful. In external form, thickness of the shell, and the rough appearance of the anterior side, the shells greatly recall some species of *Astarte* and of *Crassatella*.

3. *Megalodon*, Sow., 1827, (Min. Conch., vol. vi, p. 131). Shell ovate or sub-triangular, moderately inflated, with prominent incurved beaks, of solid structure; hinge with two generally more or less distinctly bifid cardinal teeth, the anterior being smaller than the posterior, which is considerably elongated and often of unequal size in the two valves; a thin posterior marginal lateral tooth is often present; anterior muscular impression small, deep, very close to the hinge-teeth, sometimes with a superimposed small impression, posterior muscular impression larger, elongated, occasionally on a raised lamina; pallial line entire, ligament strong, external, supported by thickened fulcra.

Gümbel, in his paper on the "Dachsteinbivalve, &c.," (Sitzb. Akad., Wien, 1862, vol. xlv, p. 361, &c.), proposes to divide the genus into three sub-genera.

3 a. *Eu-megalodon*, restricted to the palæozoic species, of which *M. cucullatus*, Sow., is the type. The form of these shells is generally considerably elongated, resembling *Megalomus*, and sometimes longitudinally carinated; the posterior cardinal tooth in the right valve is smaller and widely bifid, the corresponding tooth in the left valve very prominent and only grooved, the posterior lateral tooth is well developed.

3 b. *Neo-megalodon*, as the type of which *Meg. triqueter*, Wulfen, may be considered; the shells are sub-trigonal or cordiform, posterior cardinal teeth bifid in both valves, stronger in the left than in the right one, posterior lateral tooth indistinct or obsolete. All the species are triassic.

3 c. *Pachy-megalodon*; type, *M. chamæformis*, Gümbel, also from triassic beds. Posterior cardinal tooth single in the left, double and curved in the right valve, posterior lateral tooth short and distinct; anterior muscular impression posteriorly and inferiorly surrounded by a raised margin.

4. *Astartila*, Dana, 1849, (vide Geol. Expl. Exp., p. 688). Shell elongately sub-triangular, inequilateral, slightly inflated, moderately thickened at the beaks and near the margins, thin in the middle, on the surface concentrically striated or lamellated; ligament external, very long; muscular impressions rather large, the anterior close to the hinge and with a small superimposed impression; pallial line entire; hinge unknown. Type, *A. intrepida*, Dana.

This genus is based upon a number of carboniferous species from New South Wales; they greatly resemble in external form the sub-genus *Caryatis* of *Cytherea*, but the long ligament and the muscular impressions appear to be very similar to those of *Astarte*. The examination of the hinge-teeth is required for the correct determination of the family to which these shells belong.

5. *Conchodon*, Stopp., 1861, (Pal. Lomb., 3^{me} ser., 16^{me} livr., p. 246). Shell cordate, thick, concentrically striated on the surface, with the beaks prominent and incurved; hinge area very large, composed of three sub-equal transverse posterior cardinal teeth, the uppermost in the right valve being longest and strongly curved;

besides these there is in the right valve a large rounded anterior cardinal tooth corresponding to a cavity in the left valve; anterior muscular impression close to the hinge and somewhat irregular, posterior large, with an internal raised margin. Type, *Conchodon infraliasicus*, Stopp., from the "*Avicula contorta*-beds." The species for which this genus has been proposed greatly resembles that which Gumbel called *Pachy-megalodon*, but if the hinge, as figured by Stoppani, is correct, there is considerable difference between both. Stoppani says that there exists an internal ligament, lodged along the posterior margin; the figure of both the valves does not give any indication of such an internal ligament.

6. *Pachyrisma*, M. and Lycett, 1850, (Moll. of the great Oolite, pt. ii, p. 78). Shell cordiform, very solid, with prominent incurved beaks, concentrically striated, hinge area very large, with two slightly oblique cardinal teeth in each valve, the posterior being much larger than the anterior, which in the left valve is situated at the lunular margin; muscular impressions moderate, both very close to the hinge, the anterior deep, oblong, with a very shallow pit above it and separated from the large impression by a small raised tooth; the posterior muscular impression is situated upon a raised plate close to the hinge; ligament strong, supported by fulera.

Type, *P. grande*, M. and L. This appears to be the representant of the *Megalodons* in jurassic rocks; it seems to form a connecting link between them and the next genus.

7. *Opis*, Defr., 1825, (Pictet Traité de Pal., tom. iii, p. 305). ^{295, 1845} Shell trigonal or cordate, with very prominent, attenuated, incurved beaks and large excavated lunula; hinge with one long cardinal tooth in the right and two in the left valve, the anterior tooth forming the internal edge of the lunula; muscular impressions of moderate size, oval, ligament long, linear. Type, *O. lunulata*, Sow. This is a characteristic mesozoic genus; no species have as yet been found in tertiary rocks.

8. *Opisoma*, Stol., 1870. Shell trigonal, much higher than long, with long attenuated slightly incurved and approached beaks, lunule large and deep; hinge with three elongated cardinal teeth in each valve, and a small posterior lateral tooth situated above the posterior muscular impression, which is only slightly larger than the anterior one, both being deeply excavated. Type, *Opis paradoxa*, Buvignier, (Stat. Geol. de la Meuse, p. 17, pl. xiii, figs. 37-42). Species referable to this genus occur in upper jurassic and cretaceous rocks; in form they perfectly resemble some species of *Opis*, but the hinge is considerably different, possessing many more cardinal teeth than are to be observed in that genus.

9. *Par-astarte*, Conrad, 1862, (Proc. Phil. Acad., p. 288); I have not been able to procure more than the reference to this genus.

10. *Cypricardinia*, Hall, 1859, (Pal. New York, iii, p. 266). Shell elongately trapezoidal, moderately compressed, beaks anterior or sub-anterior, slightly prominent, surface concentrically lamellated or striated, with a posterior more or less distinct dorsal ridge; the ligament appears to have been thin; muscular

Wilson. says, Based on 1872, p. 53, that he finds the type of this
P. (Cypricardinia) is not distinct from Cypricardinia and gives it up.

impressions ovate, slightly impressed; hinge unknown. Type, *C. lamellosa*, Hall, from the Lower Helderberg (Silurian) group of North America.

This is a rather unsatisfactorily known palæozoic genus; the shells have the aspect of *Trapezium*, but appear to be thinner, and nothing is known of their hinge by which their proper classification could be decided. I insert the genus here simply on account of the resemblance which some of the species show to *Megalodon* on the one and to *Cardinia* on the other hand.

11. *Anoplophora*, Sandberger, 1862, (vide Alberti's Ueberblick über die Trias, 1864, p. 133). Shell elongated, laterally moderately compressed, inequilateral, beaks sub-anterior, hinge with a small indentation, without any perceptible cardinal teeth and with very slightly thickened lateral margins on either side; anterior muscular impression cordiform, enlarged, posterior very faint, ligament linear, external. Type, *Anop. (Myacites) fassaensis*, Schloth., sp. Most of the species referable to this genus occur in the Trias; they differ from *Cardinia* by the want of hinge-teeth, and some forms closely resemble *Pleurophorus*, but they appear to have a thinner shell. It is difficult to say what the real distinctions of the present genus are as compared with the former, and possibly they may be identical, at least in part so.

12. *Cardinia*, Ag., 1841, (Pictet, Traité de Pal., iii, p. 522). Shell trigonal or ovately elongated, compressed, inequilateral, with pointed, not very prominent, beaks, these being close together; hinge with one cardinal tooth in the right and two small ones in the left valve, and one remote lateral tooth on either side in each valve; muscular impressions deep, rather small, and situated next to the lateral teeth; ligament of moderate strength, but long. Type, *C. concinna*, Sow., sp. This genus is sparingly (and rather doubtfully) represented in silurian rocks; its maximum of development falls in the Lias, and it disappears with the close of the jurassic period.

13. *Trigonodus*, Sandberger, 1864, (vide Alberti's Ueberblick über die Trias, p. 125). Alberti introduced this name for a few triassic species, of which his *T. Sandbergeri* may be considered the type. The form of the shells is entirely that of *Cardinia*, and the hinge also appears to be nearly the same, except that the posterior lateral tooth is very strong, single in the right and double in the left valve; the anterior lateral tooth is short and small, the cardinal teeth are distinct; the muscular impressions elongated and attenuated above. The genus is said to be "totally distinct" from *Cardinia*, though it certainly does not appear to be so.

14. *Euloxa*, (? Conrad, 186? Check-list, Miocene foss., North America, Smiths. Misc. Coll., No. 183, 1864, p. 7). Shell like *Astarte*, somewhat produced posteriorly, hinge apparently with three cardinal teeth in the left valve, the two teeth on the sides being much smaller than the median one, and two teeth in the right valve. The type of this genus seems to be *Venus latisulcata*, Con., (Mioc. foss., p. 40). I have not met with the original description of *Euloxa*, and only know it from Meek's reference.

15. *Astarte*, Sowerby, 1817, (*Crassina*, Lam., 1818). Shell sub-trigonal or sub-orbicular, with attenuated, pointed, approached beaks; surface concentrically striated or laminated, hinge with three cardinal teeth in each valve; in the right the anterior and posterior are very small; in the left valve the median and sometimes posterior are large, and the anterior is sometimes only indicated, as well as a lateral tooth, situated just above the muscular impression; ligament long, generally lodged in a depression and supported by fulcra; muscular impressions rounded, or ovate, deep; internal margin of shell smooth or crenulated.

The first authentic specimens of *Astarte* appear with the mesozoic period and continue up to the present time, being mostly found in northern seas.

Mr. Conrad (Am. Journ. Conch., v, p. 46,) suggests that Sowerby's oolitic type species *Astarte lurida* is generically distinct from the recent northern forms which Lamarck called *Crassina*. I have compared this type species also with recent *Astarte*, and I find that in some of the more oval species there is also a thickening of the anterior lunular margin in the right valve, as noted in the fossil *lurida*. I do not think that they could be on that account generically separated, though I admit that there are probably several other genera represented among the fossil species which we call *Astarte*; I would particularly allude to *Eriphyla*, *Grotriania*, and *Myrtea*, a sub-genus of *Lucina*. Very closely allied to the last, if not identically the same, is Conrad's *Lirodiscus*.

15 a. *Gonilia*, Stol., 1870. Shell orbicular, small, hinge with three distinct cardinal teeth in each valve, surface with angular striæ, no epidermis; type, *Lucina*? (or *Astarte*) *bipartita*, Philippi, (Abbild. and Besch. Conch., vol. ii, *Astarte*, pl. 1, fig. 9; non *A. bipartita*, Sow.). The round, rather *Lucinoid* form and the angular striation of the surface indicates in this species a distinct section of *Astarte*, similar to *Cyclas*, a sub-gen. of *Lucina*.

16. *Grotriania*, Speyer, 1860, (Zeitsch. d. deutsch. Geol. Gesellsch., vol. xii, p. 496). Shell roundish, moderately compressed, concentrically sulcated or striated, lunula and area very deeply excavated; beaks produced and pointed, hinge with two or more (often three) cardinal teeth in the right and two in the left valve, the middle tooth in the former and the anterior in the latter being the strongest; each valve with a rib-like marginal lateral tooth on either side, accompanied by a groove, muscular impressions oval, moderately excavated, internal margin finely crenated. Type, *Grot. semicostata*, Speyer, from the oligocæne beds of Soellingen. One species also occurs in the South Indian cretaceous rocks.

This genus greatly resembles in external form an *Astarte*, but is readily distinguished from it by the presence of the peculiarly elongated lateral teeth and the deep lunula and area. The cardinal teeth equally easily distinguish the genus from *Eriphyla*, Gabb, (*DOSINIINÆ*), in which the pallial line is truncate posteriorly, or more or less distinctly sinuated.

17. *Præconia*, Stol., 1870. Oval, elongated, solid, very inequilateral, beaks sub-anterior, approached, incurved, surface concentrically lamellated or striated; muscular impressions strong; hinge with two cardinal teeth in the left and three

* Not the type at all; Sowerby distinctly states, that *Lucina Scotica*, Lam. may be taken as the type. Sowerby describes and figures *A. lurida*, first, but that does not make it the type, when he designates *A. scotica* as such.
 † Neither this diagnosis, nor his figured species agrees with Speyer's type, which is both figured and described as being entirely without lateral teeth.

in the right valve, the anterior in the latter being often obsolete and the posterior are in both elongated; sometimes there appears to be an indication of a posterior lateral tooth; type, *A. terminalis*, Römer, from oolitic rocks. This genus includes a great number of chiefly lower and middle mesozoic species; there are scarcely any known from cretaceous deposits. The well known *Ast. rhomboidalis*, Ph., is another form of the same genus. The species have been mostly referred to *Cardita*, and they are the representants of *Mytilocardia* in the *ASTARTINÆ*.

18. *Gouldia*, Adams, 1851. Shell sub-trigonal, concentrically sulcated; hinge with one sub-anterior cardinal tooth in the right and two cardinal teeth in the left valve, the anterior being very small; an elongated anterior lateral tooth is present in each valve; in other respects similar to *Astarte*. Type, *G. minima*, Montg. Species of *Gouldia* already occur in jurassic rocks, but they are not numerous, though wherever the specimens are met with, they generally are found in large numbers.

19. *Alveinus*, Conrad, 1865, (Am. Journ. Conch., i, pp. 10 and 138). "Smooth, anterior, posterior and ventral margins channeled within; hinge of right valve emarginated under the apex, and having one pyramidal tooth anteriorly; hinge of left valve with a pit under the apex, and two diverging teeth anteriorly." Type, *Al. minuta* (-us), Con.; this is apparently the same species which Conrad first (l. cit., p. 10,) noted as *A. parva* (-us), from tertiary rocks of Mississippi.

20. *Goodallia*, Turton, 1822, emend. Deshayes, (Paris foss., 2nd ed., i, p. 781; *Pachyodon*, Gabb, 1868, Am. Journ. Conch., iv, p. 198). Shell smooth or concentrically finely striated, ovately elongated, beaks anterior or sub-anterior, pointed, incurved, right valve with a single large median cardinal tooth, left valve with two comparatively small, thin, and elongated teeth, sometimes slightly bifid, and occasionally with a thin sub-obsolete lateral tooth, pallial line simple, sub-truncate posteriorly; type, *G. miliaris*, Defr., from the Paris basin. This genus appears rather numerous in eocene rocks of Europe and America; it is probable that some of the small smooth jurassic *Astarte* will also have to be referred to it.

21. *Lutetia*, Desh., 1860, (Paris foss., 2nd edit., i, p. 787). Shell small, ovate or roundish, beaks obtusely pointed; hinge with two diverging cardinal teeth and one placed longitudinally below the anterior cardinal margin in each valve. Type, *L. Parisiensis*, Desh., from the Paris basin. Only two species are as yet known.

22. *Micromeris*, Con., 1866, (Check-list, eocene fossils; Smith. Misc. Coll., No. 200, p. 5). As the type of this genus Lea's *Astarte parva* and *minor* (Contb., p. 63,) have probably to be considered. The shells are trigonal, with produced somewhat attenuated rather straight beaks, ventrally rounded, slightly inflated, striated, or sulcated on the surface; the hinge appears to have two small cardinal teeth in the left and one in the right valve, and one long posterior lateral tooth this in each. Conrad (l. cit.) also refers *Astarte minutissima*, Lea, to *Micromeris*, but for he formerly proposed the name *Pteromeris*.

23. *Goodalliopsis*, Rain. et M.-Chalmers, 1863, (Journ. de Conchil., p. 194). Shell similar to *Goodallia*, but the hinge has two cardinal and one distinct, elongated posterior lateral tooth in each valve; the authors of the genus simply say, *dentibus lateralibus elongatis, prominentibus*, which may mean that both anterior and posterior lateral teeth are present, but the figure of the hinge does not show any anterior lateral teeth. The type species, *G. Orbignyi*, is from the eocene beds near Fercourt.

24. *Woodia*, Desh., 1860, (Paris foss., 2nd edit., i, p. 790). Shell sub-orbicular, with obtuse beaks, slightly tumescent, margins internally crenulated; hinge with one large grooved cardinal tooth in the right and two diverging teeth in the left valve; sometimes with small sub-obsolete lateral teeth close to the cardinal. Type, *W. digataria*, L., from the Mediterranean. Deshayes describes three eocene species from the Paris basin. The genus appears to differ from *Goodallia* only by its more rounded shape and internally crenated margins, the hinge being in both very similar.

b. *Sub-family*,—*CARDITINÆ*.

25. *Matheria*, Billings, 1858. Shell elongated like *Pleurophorus*, concentrically striated, beaks anterior, hinge of left valve with two, of the right with one small cardinal tooth; type, *M. tenera*, Bill., from the Trenton group of Canada, (see Geol., Canada, vol. i, p. 147).

26. *Pleurophorus*, King, 1848, (Perm. foss., p. 180). Shell elongated, very inequilateral, moderately tumid, posterior surface radiately ribbed; hinge with two radiating cardinal, and one posterior lateral tooth in each valve; anterior muscular impression very deep with a small superimposed pit. Type, *P. costatus*, Brown, sp. King mentions that the triassic *Cardita crenata*, Goldf., also belongs to this genus, but its cardinal teeth are more similarly formed to those of *Cardita* than to the type of *Pleurophorus*, and the species, therefore, is rather referable to the next genus.

27. *Palæocardita*, Con., 1867, (Am. Journ. Conch., iii, p. 11). Shell elongately trapezoid, inequilateral, moderately inflated, radiately ribbed; hinge with two blunt cardinal teeth and one posterior lateral tooth in each valve. Conrad proposed this genus for the triassic *Cardium austriacum*, Hauer, (*Cardita id.* apud Stoppani), but the better known Cassian *Cardita crenata* may rather be considered as the type of the genus. The principal cardinal tooth is thick and blunt, formed exactly as in *Cardita*, and what is termed anterior cardinal is, strictly speaking, a sub-lunular tooth, and could with equal propriety be called anterior lateral. I believe that to this genus should also be referred a great number of cretaceous *Carditæ* of the type of *C. Dupiniana*, d'Orb. I have seen small specimens of this species without a trace of a lateral tooth, but one large specimen in our collection has a small, though distinct, posterior lateral. These cretaceous *Carditæ*, or *Mytilicardiæ*, mostly differ from the recent species of the last genus by the want of an anterior insinuation of the ventral margin, where in true

Mytilicardiæ there should be a small gape; the posterior cardinal is also less elongated in the fossil forms.

28. *Pleuromeris*, Con., 1867, (Amer. Journ. Conch., iii, p. 12). Shell sub-triangular, radiately ribbed, hinge in the right valve with one broad, furrowed, recurved tooth, in the left with three teeth, the anterior one small and fitting into a cavity in the opposite valve. Type, *Cardita tridentata*, Conrad, (Mioc. foss., p. 76).

29. *Miodon*, Carp., 1864, (Ann. and Mag. Nat. Hist., 3rd ser., vol. xiv, p. 424). Carpenter describes as the type of this genus *M. prolongatus*, a recent species. This shell is ovately sub-trigonal, small, solid, ventrally much produced, with the umbones situated anteriorly, radiately ribbed, the ribs being partially intersected by concentric sulcations; hinge in the right valve with one posterior cardinal and one anterior lateral tooth, left valve with one triangular anterior and one elongated posterior cardinal, and a very small anterior lateral tooth.

It is rather difficult to point out the difference of this genus from *Pleuromeris*; both appear to be very much alike, for the interpretation of the hinge-teeth in these minute shells is generally not an easy task. Carpenter says that a species of *Miodon* made its first appearance in the great oolite with *Astarte orbicularis*, Sow., (Min. Conch., pl. 444, figs. 2 and 3). Sowerby (l. cit., p. 64,) describes two species, *A. orbicularis* and *pumila*; the figures on the plate have been transposed, neither of the species is radiately ribbed, the first has an anterior lateral tooth in the right valve, the second has an anterior and posterior in the same; they do not belong to the same genus, but as I am not acquainted with the species themselves, I would not venture to pronounce anything certain regarding their generic determination. The first species is perhaps an *Eriphyla* (*DOSINIINÆ*), and the second a *Gouldia*. Carpenter further refers to his *Miodon* an *Astarte corbis*, which is said to appear among "Searles Wood's Crag series." I do not find the species mentioned in S. Wood's Crag fossils, but he has a *Cardita corbis*, the description of which closely resembles that of *Miodon*.

30. *Pteromeris*, Con., 1865, (Am. Journ. Conch., i, p. 9). This was proposed for another small triangular radiately ribbed species, *Astarte minutissima*, Lea, (Cont., p. 64, pl. 2, fig. 39); it appears to have two minute cardinal teeth in the left, one in the right valve, and a long posterior lateral in each. In his list of North American eocene shells, (Smith. Misc. Coll., No. 200, 1866), Conrad quotes the same species as *Micromeris*, which again shows the uncertainty prevailing in the determination of these little shells. Meek in the list of North American miocene shells (Smith. Misc. Coll., No. 183, 1864,) quotes two species, *Venericardia* (*Pteromeris*) *abbreviata*, Con., and *V. (Pt.) radians*.

31. *Cyclocardia*, Con., 1867, (Am. Journ. Conch., iii, 191). "Rounded, radiately costate, covered with a rough epidermis; hinge with two robust teeth in the left valve, directed obliquely backwards, the posterior one elongated and slightly curved; anterior tooth of the right valve rudimentary." Type, *C. borealis*, Con. The author states that this form differs from *Cardita* by the rough brown epidermis' and by the anterior cardinal tooth being obliquely directed backwards, and an

elongated anterior muscular impression. Whether these differences hold good in a comparison with the type species of the next genus appears very doubtful.

32. *Venericardia*, Lam., 1801. Recluz in an account on the anatomy of *Cardita* and *Venericardia* (Journ. de Conch., 1862, vol. x, p. 109, &c.), considers as the type of the latter genus *V. australis*? figured in Enc. meth., p. 232, fig. 5, and points out that this species has a peculiar posterior partition in the mantle, in which there is a single siphon included, and it has two pairs of gills on each side, while all the *Carditæ*, he states, have two siphons without a partition and only one gill on either side. The shell is sub-trigonal, moderately inflated, radiately ribbed; hinge with one somewhat posterior cardinal tooth in the right, and two in the left valve, the posterior being elongated, as in *Cardita*. According to this account there would seem hardly any doubt as to the distinction of the animal of *Venericardia australis* from that of *Cardita*, but it is still necessary to know something more of the characters of the animals and shells of this and allied species before it is advisable to make use of the distinctions indicated in the determination of shells alone.

Formerly such forms as *Cardita antiquata*, Linn., with a roundly trigonal shape, have been referred to *Venericardia*, but this character of form seems now insufficient, because in every other respect of shell-structure there is no essential difference to be traced from the next genus. Recluz says that the specimen which he examined is from the Senegal. Should the species not be the same as "*C. ajar*" of Adanson, which is Blainville's type of *Cardiocardita*? This last name has lately been again introduced by some American authors as a sub-genus of *Venericardia*, but what its distinctive characters properly are I have not been able to ascertain.

Lamarck's type of *Venericardia* is apparently *Venus imbricata*, Gmelin, a fossil species from Grignon. This, judging from Deshayes' figure in his first edition of the Paris fossils, seems to be very closely allied to Conrad's *Cyclocardia*, having two elongated oblique posteriorly directed cardinal teeth in the left valve and a somewhat elongately oval anterior muscular impression. Now, it is required to ascertain whether these (apparently not very important) characters of the shell also occur in the form quoted by Recluz as *Ven. australis*? and whether this is the same as (*Cardita*) *ajar* of Adanson. Should these suppositions prove correct, *Venericardia* and *Cardiocardita* would be identical, and probably also *Cyclocardia*, and Recluz's examination of the animal would apparently confirm the propriety of the generic distinction. But how many other fossil forms have to be referred to *Venericardia* will depend from a further very careful examination and comparison of the species. I do not think that we have as yet sufficient materials to carry out Recluz's suggestion to the effect, that *Venericardia* belongs to an altogether different family from that of the *ASTARTIDÆ*. Some discrepancy certainly exists between his anatomical account and what I saw of the anatomy of *Cardita* and *Mytilicardia*, and until many more species have been examined, I do not think any generalisation of the conclusions will be very sound. What should in such a case be, for instance, done with *Gouldia*, when compared with

Astarte? The cases are perfectly similar (see p. 273, &c.). A slight alteration of an organ for a certain purpose may not always be equivalent to a change in the entire organisation of the animal!

33. *Cardita*, Brug., 1789, (*Actinobolus*,* Klein, apud H. and A. Adams). Shell rounded or cordiform, strongly radiately ribbed; hinge with one strong triangular cardinal tooth in the right and two teeth in the left valve, the posterior one being moderately elongated; anterior muscular impression somewhat elongated with a small pit above it, posterior muscular impression broadly oval, pointed above. Type, *Car. sulcata*, Lam. I have already pointed out the difficulty in properly distinguishing between *Venericardia* and *Cardita*. We must await further examination on this point. In the determination of the shell we shall very probably not be able to make use of these indicated generic distinctions. *Cardita* is sparingly represented already in the early mesozoic epoch and continues up to the present time.

Conrad called some of the cretaceous species at first *Pseudocardia* (Am. Journ. Conch., 1866, ii, p. 103), for which name he subsequently substituted *Vetocardia* (ibid, 1868, iv, p. 246), as the type of which *Venericardia Dupiniana*, d'Orb., can fairly be taken. I have perfect specimens of both the valves of this species before me, and I can see no great difference between them and other typical *Carditæ*,—form of shell, hinge-teeth, muscular and pallial impressions are almost perfectly identical in both, except perhaps that the posterior cardinal teeth are less elongated and thicker. In one large specimen of the left valve, there is, as already stated, a distinct indication of a posterior lateral tooth, but in two other somewhat smaller well preserved valves there is no trace of it. If at all distinguished from *Cardita* these forms are identical with *Palæocardita*, (see p. 280), but certainly the name *Vetocardia* has no signification. In vol. v, p. 48, of Am. Journ. Conch., Conrad gives a fresh characteristic of the hinge from a Haddon-field specimen. It quite agrees with that of *Ven. Dupiniana* of d'Orbigny.

34. *Mytilicardia*, Blainv., 1824. Shell elongated and tumid, hinge-teeth quite similar to those of *Cardita*, but thinner, internally insinuated below the beaks, and generally somewhat more elongated than in the former genus; anterior muscular impression rounded, posterior somewhat elongated. Type, *M. calyculata*, Brug.

The difference between *Mytilicardia* and *Cardita* is to a certain extent really a structural one, though at first it does not appear to be very marked. The very inequilateral form of the shell with almost quite anterior or sub-terminal tumid, but very closely approached beaks, causes an essential and constant change in the form of the hinge-teeth, though their number remains quite the same. H. and A. Adams say that the posterior cardinal tooth in the left valve is double, which is comparatively rarely the case, and I have not seen a single

* Pending the differences to be yet traced out between the former and the present genus, I think it more advisable not to introduce Klein's name, but retain that of Bruguière, especially as it had been shortly after its proposition carefully emended by Lamarck.

species in which the two laminae forming it were equally developed. The fulcra supporting the ligament may be sometimes taken for a part of the tooth, but they do not, strictly speaking, belong to it. The anterior muscular impression is in *Mytilocardia* usually the smaller one, while in *Cardita* it is larger than the posterior. Many of the species of the present genus (as restricted) also differ in habitat from the former, being commonly found in holes of rocks and corals, though not apparently perforating them voluntarily. The animal has a small foot with a distinct byssus which is wanting in *Cardita*.

H. and A. Adams distinguish three sub-genera under the names of *Beguina*, Bolten, *Glans*, Mühlf., and *Thecalia*, H. and A. Adams. Of the first, *M. semi-orbiculata*, Linn., of the second, *M. trapezia*, Linn., are to be considered as types; the species differ slightly in form and habitat, and may be said to form convenient sections of the genus. The last which has been proposed for *Cardita concamerata*, Chem., has the interior margin peculiarly folded on itself.

35. *Carditamera*, Con., 1838, (Mioc. foss, p. 11; *Lazaria*, Gray, 1853, apud H. and A. Adams). Shell elongated, moderately tumid, inequilateral, beaks depressed, sub-anterior, surface strongly radiately ribbed; hinge with two cardinal and two lateral diverging teeth in each valve, the posterior teeth being in each case much elongated, the anterior short and more or less pointed, sub-lunular. Type, *C. arata*, from miocene beds of North America. Of recent species only few have been described under the name of *Lazaria*.

LIST OF CRETACEOUS SPECIES.

Opis (see Pictet and Campiche, Pal. Suisse, 4^{me} ser., 3^{me} part., p. 327).

1-16.—*Opis Neocomiensis*, Isaræ, Lorioli, Dubisiensis, Mayori, ornata, Hugardiana, lineata, Coquandiana, elegans, Guérangeri, Ligeriensis,annoniensis, Truellei, bicornis,* and pusilla are enumerated by Pictet and Campiche. The form of *Opis* is so characteristic that the genus cannot be easily mistaken with another, but which of the species belong to the genus *Opisoma* can only be decided by the examination of the hinge. I have only seen tolerably good specimens of *bicornis*, which is an *Opisoma*; and the same is most probably the case with *Truellei*.—*O. galeata*, d'Orb., *Cardium galeatum*, Müller, is a *Trigonocælia* (vide postea, family *ARCIDÆ*).

17.—*Op. Cenomanensis*, Guéranger (Album pal. de la Sarthe, 1867, pl. 16, fig. 3). The figure is very indistinct, it is impossible to identify the species from it.

18-19.—*Op. megalodus* and *brevirostris* are described by Eichwald from Russia (Leth. ross., 10^{em} livr., pp. 634 and 637).

20.—*Op. bioculata*, Kner, sp., (*Cardita*), Favre, Desc. Moll. foss. de Lemberg, 1869, p. 117, is a very remarkable bilobate form, and it would be interesting to examine its hinge.

21-23.—*Op. bicarinata* and *bella*, Conrad, (Journ. Phil. Acad., new ser., iii, p. 327,) and *Op. Haleana*, d'Orb., (Prod. ii, p. 238,) are the only species as yet recorded from America; they are all very insufficiently characterized, and Meek in his Check-list of cretaceous fossils (Smiths. Misc. Coll., No. 177, 1864, p. 11,) questions their generic determination.

24.—*Op. undata*, Con., is quoted from Palestine.

* This species of Geinitz is identical with d'Orbigny's *O. Galliennei* (Pal. franç. cret., pl. 257 bis, fig. 5,) which is not mentioned in the text, nor in the Prodrome. *O. Truellei*, which d'Orbigny (Prod.) and Pictet identify with *bicornis*, differs by being less high and having the ventral margin produced, convex, while in *bicornis* it is truncate. (See also Guéranger in Album Pal. de la Sarthe, 1867, pl. 22, fig. 13.)

25-26.—*Opis repleta* and *Opisoma Genitziana*, n. sp., are found in the lower series of the South Indian cretaceous deposits.

Astarte (see Pictet and Campiche, l. cit., p. 316).

There are particularly three genera of shells, *Cyprimeria*, *Dosinia*, and *Eriphyla* (see p. 156), with which fossils of the form of *Astarte* can easily be confounded, when the internal structure of those fossils is not well preserved. *Eriphyla* especially seems to be largely represented among the fossil *Astarte*, as recorded at the present time, and probably all the species which have an indication of a posterior pallial sinus belong to the former genus; they can scarcely be referred to *Astarte*, for the single anal opening which the animal of this last possess lies behind the posterior muscular scar, but not below it, where the formation of a sinus, if present, must be due to the development of muscles supporting a branchial siphon, or at least a special branchial opening; neither of these are, however, present in *Astarte*.

27-31.—*A. gigantea*, *helvetica*, *Beaumonti*, *transversa*, and *Moreana* are probably all species of *Eriphyla*; the inequilateral shape and large size of the shells does not agree with *Astarte*.

32-44.—*A. Valangiensis*, *pseudostriata*,* *illunata*, *Germani*, *Marcouana*, *Icaunensis*, *disparilis*, *Essertensis*,† *subcostata*,‡ *numismalis*, *subformosa*, *Fittoni*, *subacuta* are all neocomien species, mostly of a characteristic sub-triangular form.

45.—*A. subdentata* is a *Gouldia*.

46-47.—*A. elongata*§ and *sinuata*; the former is much elongated, but in other respects true to the type; it has not the oblique hinge-teeth of *Præconia*.

48.—*A. ? discus* is probably a *Cyprimeria*, or rather an *Eriphyla*, as it appears to possess a deep lunule.

49.—*A. Astieriana*.

50-52.—*A. obovata*, *Buchi*, and *lævis* are species of *Eriphyla*.

53.—*A. Dupiniana*? may be a *Cyprimeria*.

54-55.—*A. Rhodani* and *Sabaudiana* have apparently the deep lunule, and the first also the small pallial sinus, of *Eriphyla*.

56.—*A. Alobrogensis* is probably a *Grotriana*.

57-58.—*A. Bellona* and *Pictetiana*.

59-60.—*A. striata* (*Koninckii*, D'Arch.)|| and *concinna* are species of *Eriphyla*; they are both from Blackdown and most likely one and the same species.

61.—*A. formosa*, ? a *Gouldia*.

62.—*A. multistriata*. I do not know a single genus of the *ASTARTIDÆ* in which to place this remarkable shell; the radiating striation between the concentric lamellæ and the large circumscribed lunula strongly suggest a comparison with *Venus*, particularly the species of the sub-genus *Chione* (*VENERIDÆ*, p. 148).

63.—*A. Guerangeri* (see Guéranger, Album Pal. de la Sarthe, 1867, pl. xvi, fig. 6,) also does not appear to be an *Astarte*; the shell should be compared with *Lucinopsis* (*TELLINIDÆ*, p. 121).

64.—*A. angulata*, Guéranger, (Alb. pal., l. cit., pl. xvi, fig. 5,) is a *Gouldia*.

65.—*A. granum*, Math., sp., (*Venus id.*, Cat. org. foss., p. 153, pl. 15, figs. 7-8). The convexity of the shell, noticed in Matheron's description, would suggest that the species rather belongs to *Lucina* than to *Astarte*.

* *A. substriata*, Leym., apud Eichwald, l. cit., p. 631.

† Rech. Geol. de la Savoie, &c., par A. Favre, tome i, 1867, p. 377, pl. C, fig. 11.

‡ This is *A. laticosta* of Deshayes apud Leymerie. Eichwald (Leth. ross., 10^{em} livr., p. 627,) quotes it under that name from the so-called neocomien beds near Khoroschówo. Deshayes in a letter to Zittel suggests to call it *Leymerii*, which must give way to d'Orbigny's name (see Denksch. Akad., Wien, xxiv, 1865, pt. ii, p. 156, and also Coquand, Monog. Étage Aptien, 1865, p. 126).

§ *Ast. Ræmeri*, Rouill., apud Eichwald, Leth. ross., 10^{em} livr., p. 630.

|| Errore typico *Konducki*, d'Arch., apud Eichwald, Leth. ross., 10^{em} livr., p. 633.

- 66.—*A. difficilis* has a very characteristic name, for all we know of it is that it is "round."
- 67-68.—*A. similis** and *laticostata* are species of *Gouldia*.
- 69.—*A. Gümbelii*.
- 70-74.—*A. acuta*, *nana*, *porrecta*, *cælata*† and *Ræmeri*‡ are apparently *Gouldiæ*.
- 75.—*A. Benedeni*, Müller, (Pet. Aach. Kreidef. Suppl., 1859, p. 11, pl. 7, fig. 12); this may be a species of *Pleuromeris*, or *Cyclocardia*, but it does not agree with *Astarte*.
- 76.—*A. Miqueli*, Müller, (*ibid.* p. 12, pl. 7, fig. 13,) strongly recalls the form of an *Eriphyla*.
- 77.—*A. circularis*, Guéranger, (Album pal. de la Sarthe, 1867, pl. 15, fig. 12, and pl. 16, figs. 7-8).
- 78.—*A. Mosquensis*, d'Orb., (Eichwald, Leth. ross., x livr., p. 621,) is considered a neocomien species and is most probably an *Eriphyla*.
- 79.—*A. borealis*, d'Orb., non Nilson, (Eichwald, *ibid.* p. 622). The change of the specific name may be deferred until the generic character of this species has been fully ascertained.
- 80-81.—*A. Veneris* and *ovoides*, Buch, Eichwald, *ibid.* pp. 625 and 628.
- 82-83.—*A. porrecta*, Buch, and *sub-obtusa*, d'Orb., Eichwald, *ibid.* pp. 629 and 630, from the Neocomien of Russia.
- 84-89.—*A. lurida*, *dimidiata*, *gravida*, *princeps amygdala*§ and *triangularis* (non *idem* Mont., a recent species,) are described by Coquand from the Aptien of Spain (Monog. de l'étage Aptien, &c., 1865, p. 122, &c.). None of the species are very characteristic forms as compared with typical *Astarte*, but as neither the hinge-teeth nor the internal characters of the shells are pointed out, it seems useless to suggest any alterations in the generic names.
- 90-91.—*Astarte mantica*, Loriol, (Pal. Suisse, 4^{me} ser., Monog. de l'étage Valangien, &c., 1868, p. 29,) is to all appearance a true *Præconia*, and to the same most probably also belongs *Cardita cultrigera*, Loriol, (*ibid.* p. 30).
- 92-99.—*A. cardiniformis*, *amygdala* (non *idem* Coq., 1865,) *lacryma*, *saharensis*, *Adherbalesis*, *Gabæ*, *punica*, and *Delettrei* are noticed by Coquand from the Province Constantine (Geol. and Pal. Const., 1862, pp. 196-197).
- 100.—*Ast. Herzogii*, Krauss, (Nov. Acta Acad. Leop. Carol., xxii, pl. ii, pp. 447, &c.), from the so-called lower cretaceous (? jurassic) beds of South Africa, is a *Grotriania*.
- Ast. Bronni*, Krauss, *ibid.* p. 449, is most probably a *Remondia* (see further on, family TRIGONIIDÆ.)
- 101-107.—*A. crenulata*, *gregaria*, *lineolata*, *octolirata*, *pasilis*, *Texana* and *Washitaensis* are quoted from North America in Meek's Check-list of cretaceous fossils (Smiths. Misc. Coll., No. 177, 1864, p. 11).
- 108-110.—*A. Conradiana*, *Mathewsonii*, and *Tuscana* are from California (Pal. Calif., i, pp. 178-179).
- 111.—*A. dubia*, d'Orb., Voy. Am. merid., tom 3^{me}, 1842, p. 105.
- 112-113.—*A. truncata*, Buch, (*ibid.* p. 25), and *A. exotica*, d'Orb., (*ibid.* p. 83); the last is either a *Præconia* or a *Caryatis*.
- 114-124.—From Palæstine Conrad described in Off. Rep. of Lynch's exped. *A. mucronata*, *undulosa*, *lucinoides*, *sub-cordata*, *Syriaca*, *orientalis*, *pervetus*, *engonata* (?), *arctata*. I only know these names from Fraas' reference in Würt. Natur. Jahresh., xxiii, 1867, p. 234; he says that the last seven names are based upon undeterminable casts. *A. undulosa* he believes to be *A. formosa*,

* Favre (Moll. foss. de Lemberg, 1869, p. 115,) identifies with this species *A. sub-æquilateralis*, Alth, from Galicia.

† See *Gouldia planissima*, Forbes, p. 289.

‡ Müller, 1851, non *A. Ræmeri*, Rouill. (Bull. de Mosc., 1849, p. 395, pl. m, fig. 103); = *A. elongata*, d'Orb.

§ Non *A. amygdala*, Coquand, Constant., 1862, p. 196, pl. 8, figs. 19-20.

Sow., and quotes besides *A. substriata*, Leym. = *pseudo-striata*, d'Orb. Pictet and Campiche (Pal. Suisse, 4^{me} ser., 3^{me} part., p. 322,) add from Lynch's exped. *A. linteata* and *sub-lineolata* of Conrad.

125.—*Astarte corbicula*, Con., (Am. Journ. Conch., iii, p. 12), is changed by the same author (American Journ. Conch., v, p. 43,) into *Vetocardia crenulirata*, Conrad (? = *Astarte crenulirata*, Lea). I have already noticed the strange association of fossils which Mr. Conrad first quoted as species of his genus *Vetocardia*, but even those which he subsequently regards as typical of that supposed genus are, I believe, as regards character of the hinge, not distinct from his *Palæocardita*.

126-127.—*Gouldia decemnaria* and *declivis*, Con., (Am. Journ. Conch., v, p. 48), are from New Jersey.

128-130.—The following species occur in the South Indian cretaceous deposits: *Grotriania jugosa*, *Gouldia planissima*, and *G. trigonioides*.

Cardita (see Pal. Suisse, 4^{me} ser., 3^{me} part., p. 339).

The distinctions between *Cardita* and *Mytilicardia* can only be indicated from the external shape of the shells; which of them should be referred to *Venericardia* it is for the present quite impossible to say. If we have to go by the comparison of recent forms with fossils, (and there is no better course to be adopted), there certainly appear to be very few cretaceous *Carditæ*.

131-138.—*C. Sanctæ-crucis*, *Neocomiensis*, *quadrata*, *Villersensis*, *Stabileana*, *Orbignyana*, *Faldensis*, *fenestrata*, are forms which are closely related to *Mytilicardia*; it is possible that Conrad's name *Palæocardita* may be more appropriate for them (vide p. 280), but I have no good specimens of any of these species for examination. *C. fenestrata* is not unlike a *Venerupis*.

139.—*C. Meriani* resembles in form *Pleuromeris*, and also *Pteromeris*, of Conrad.

140.—*C. Gurgycensis*.

141-152.—*C. Dupiniana*, (see p. 280), *exaltata*, *tenuicosta* (? = *Venericardia tenuicosta*, Sow, apud Fitton), *clathrata*, *rotundata*, *Constantii*, *Argonensis*, *Cenomanensis*,* *dubia*, *Guerangeri*,* *tricarinata*,* *Cottaldina*, are all of the same type and have to be referred either to *Mytilicardia* or to *Palæocardita*.

153-154.—*C. parvula* and *semistriata* may be true *Mytilicardiæ*, but the specimens figured are very imperfect.

155.—*C. Genitzii*, (*Ven. tenuicosta*, Sow., apud Geinitz) is a peculiar form which should be carefully examined whether it belongs at all to the present group of shells.

156.—*C. granigera* is either a true *Cardita*, or possibly a *Pteromeris*.

157.—*C. Reynesi* is a true *Mytilicardia*.

C. biloculata is an *Opis* (see p. 284).

158.—*C. Hebertiana* is said to be a quadrangular, ribbed species!

159.—*C. pinguis*, Coquand, Mon. Étage Aptien de l'Espagne, 1866, p. 122.

160-164.—*C. Forgemolli*, *Nicaisei*, *Delettrei*, *Beuquei*, and *Bocchi* are described by Coquand from Algiers (Geol. and Pal. de la Prov. Constant., 1862, pp. 199-201, &c.).

165-172.—*C. eminula*, *subquadrata*, and *subtetrica* are from North America (see Meek's Check-list of cretaceous fossils, Smiths. Misc. Coll., No. 177, 1869, p. 11). Conrad has besides from the so-called lower eocene (? cretaceous) beds *Venericardia Blandingi*, *densata*, *Hornii* (= *planicosta*, Con., an *idem* Lam.)†, *perantiqua*, and *regia* (see Check-list eocene foss., Smiths. Misc. Coll., No. 200, 1866, p. 5).

173.—*C. veneriformis*, Gabb, Pal. Calif., i, p. 215; (?) *C. alticosta*, Gabb, (ibid., vol. ii, p. 268).

174.—*Cardita Jaquinoti*, d'Orb., is the only species which occurs in Southern India.

* See Guéranger, Album paléont. de la Sarthe, &c., 1867, pl. xvi.

† See Pal. Calif., ii, p. 243.

OPIS, *Defr.*, 1825, (see p. 276).

1. OPIS REPLETA, *Stoliczka*, Pl. X, Figs. 9-10.

O. testa sub-quadrangulari, inæquilaterali, tumida, umbonibus attenuatis, valde projicientibus instructa, concentrice confertim costulate striata; lunula lata ovato-cordata, profunda; area minori, moderate excavata; cardine dente unico crasso in valvula dextra, duobus in v. sinistra alterum amplexentibus instructo; impressionibus muscularibus rotundate ovatis, haud profundis; margine interno obsolete crenata.

Height of shell (including the prominent beaks)	:	its length	...	1.13
Thickness of same	...	...	...	0.84

This is an almost rectangular, strongly tumid species, inequilateral, and with very prominent attenuated beaks, with the surface rather coarsely concentrically striated; the lunula is larger* and deeper than the area; the internal margin is obsoletely crenulated. The cast (fig. 9) shows the impression of a large median cardinal tooth in the right and two teeth in the left valve, proving the species to be a true *Opis*.

Locality.—West of Odium, in an earthy limestone; only the two figured specimens were found.

Formation.—Ootatoor group.

OPISOMA, *Stol.*, 1870, (see p. 276).

1. OPISOMA GEINITZIANA, *Stoliczka*, Pl. X, Fig. 11.

Op. testa subtriangulari, angusta, inæquilaterali, umbonibus sub-obtusis antice versus incurvis instructa, antice rotundata, postice obtuse angulata et producta, carina forti et prominenti ab umbonibus ad terminationem infero-posteriorem decurrente suppeditata; margine inferiori fere recto; lunula cordiformi, lata, profunda, intus minute striata, fere dimidio totius altitudinis testæ æquante; area altitudini testæ æquante, moderate excavata, medio elevata; superficie costulis concentris confertissimis, in regione areali minus distinctis tecta; cardine in valva dextra dentibus tribus cardinalibus perlongis instructo.

Height of shell	:	its length at the inferior margin	...	...	1.26
Approximate thickness of both valves about equal to the length of shell.					

This elegant form is closely allied to *P. bicornis*, described by Prof. Geinitz from the Plæner beds of Saxony; it differs from this species by being a little longer and more regularly triangular, while at the same time in the European fossil the beaks are higher and more attenuated.

Locality.—Near Moraviatoor, in an earthy limestone; only three imperfect specimens were found.

Formation.—Ootatoor group.

* In fig. 10a (pl. x) the lunula ought to be somewhat larger; the figure only shows the internal lunular space, but the shading does not exhibit the thick and broad prominent margins surrounding it. The size of the lunula is well indicated in fig. 9a.

GROTRIANIA, *Speyer*, 1860, (see p. 278).1. GROTRIANIA JUGOSA, *Forbes*, Pl. X, Figs. 12-14.1846. *Lucina jugosa*, *Forbes*, *Trans.*, *Geol. Soc.*, *Lond.*, vii, p. 142, pl. xvii, fig. 7.1847. „ *ornatissima*, *d'Orbigny*, *Voy. d'Astrolabe*, *Paléont.*, pl. iv, figs. 27-28;—*Lucina jugosa*, *auctorum*.

Grot. testa orbiculato lentiformi, superficie concentrice crasse costulata et minutissime striata, apicibus deplanatis et valde approximatis; margine lunulari paululum insinuato; lunula et area profundissime excavatis, earumque marginibus acute projectis; cardine dente antico cardinali in utraque valva sub-obsoleto, duobus positivis majoribus, quorum medio in v. dextra maximo, dente laterali postico in valva dextra, antico in valva sinistra sub-obsoletis instructo; impressione muscul. antica obliqua obovata, postica paulo minore, fere circulari; margine interno minutissime denticulate striato.

Height of shell about equal to its length.

Thickness of shell : its length 0.47

The orbicular form, slightly but very regularly convex valves, with flattened umbonal regions, the very deeply excavated lunula and area, the concentric lamellar ribs, which are besides covered with very fine striæ of growth, and the fine internal crenulation of the margin are the most prominent characters of this interesting species. It is a true *Grotriania*, that is, an *Astarte* with deeply excavated lunule and area.

Locality —Near Odium, in a ferruginous earthy limestone.*Formation*.—Ootatoor group.GOULDIA, *Adams*, 1851, (see p. 279).1. GOULDIA PLANISSIMA, *Forbes*, Pl. X, Fig. 3.1846. *Astarte planissima*, *Forbes*, *Trans.*, *Geol. Soc.*, *Lond.*, vii, p. 143, pl. xv, fig. 23.1847. „ *cælata*, *Müller*, *Petref. Aach. Kreidef.*, p. 22, pl. ii, fig. 3.

Gould. testa sub-quadrangulari, compressiuscula, margine areali et lunulari ad apicem angulum fere rectum formantibus, regione umbonali deplanata, postice paulo angustiore quam antice, et rotundate truncata; superficie costis paucis (6-9) crassis concentricis tecta; cardine in valvula sinistra duobus dentibus cardinalibus, crassiusculis et uno postico elongato laterali, in val. dextra tribus cardinalibus, medio maximo alteris sub-obsoletis, et uno laterali antico longo instructo.

Height of shell : its length 0.90

Thickness of both valves : „ 0.57

I have compared authentic specimens, received from Dr. Bosquet, of Müller's *Astarte cælata*, and I can see no perceptible difference between them and our shell. The flattened umbones and the comparatively few but very strong concentric ribs characterize the species, and distinguish it apparently from Münster's

Card. testa orbiculato quadrangulari, paulo longiore quam alta, tumida, inæquilaterali, umbonibus incurvis, approximatis, fere terminalibus instructa, superficie multicostata, costis ternatis parte mediana maxime elevatis et spinulose tuberculatis sulcis profundis fere æquidistantibus separatis; cardine in valva dextra dentibus

duobus crassis divergentibus, antico brevi, postico valde elongato, in valva sinistra dente mediano parvulo, postico tenui et elongato instructo.

Height of shell	:	its length	...	...	...	0.84 - 0.86
Thickness	„	:	„	...	...	0.77 - 0.80

Although approaching to an orbicular form, this species is always a little longer as compared with its height. The ribs when well preserved are tricarinate, separated by very deep sulci. In each rib the median portion is the most prominent and ornamented with sharp laterally compressed tubercles. The lateral ridges appear to be nearly smooth; they are in some specimens more strongly developed than in others; there is, however, also on these a fine crenulation to be observed. Again, in some other specimens, particularly those of smaller size, the lateral ridges are nearly obsolete (see fig. 15), and the intermediate sulci are then considerably increased in width. If in such specimens the tubercles become worn off, they attain a rather different aspect from that they originally possessed; such worn specimens had been figured by Forbes as *Card. orbicularis*, and as *Card. Jaquinoti* by d'Orbigny.

I am not quite certain about the identification of Forbes' *Cardita striata*, but I have no other species from the South Indian cretaceous rocks to compare with it. Upon examining Forbes' original in the collection of the Geological Society of London, I found it much broken on the upper and posterior margins. The form and convexity of the shell and the number of ribs are in both (it and *orbicularis*) the same; the surface is in the former much worn down, but the radiating striæ on the ribs are tolerably distinct. I found in our specimens of *orbicularis* that, when the median portions of the ribs with their tubercles break off, this portion becomes bipartite, and thus with the addition of the lateral ridges each rib becomes quadripartite. I regard the specimen described under the name of *C. striata* as a form of *orbicularis* in this altered stage. At least, unless proved by the discovery of better materials, it seems impossible to form any other conclusion.

The hinge of the right valve of *Jaquinoti* has two unequal diverging cardinal teeth; the anterior is shorter than the posterior, and both are of considerable thickness; in the left valve there is a small tubercular median cardinal and a much elongated, rather thin, posterior cardinal tooth. This dentition corresponds well with that of typical *Cardita* and not with *Cardium*, to which genus d'Orbigny referred the species.

Locality.—Ninnyoor, in white or brownish limestone; not uncommon.

Formation.—Arrialoor group.

XXIX. *Family*.—CRASSATELLIDÆ.

The animals have the mantle margins disunited, entire or finely ciliated at the edges, especially posteriorly; the foot is sub-triangular, compressed; the gills rounded in front, pointed posteriorly and produced, reaching below the posterior muscular scar; there are two sub-equal leaflets on each side, the outer smaller than the inner; the palpi are sub-triangular, of moderate size, pointed behind.

The shells are oblong, posteriorly usually somewhat produced, mostly concentrically striated or sulcated, covered with an epidermis; hinge with a few cardinal teeth, and a cartilage pit in both valves; lateral teeth, if present, slightly developed, elongated; pallial line entire.

There are only a few genera referable to this family, as *Pronoe*, *Ptychomya*, *Anthonya*, and *Crassatella*, of which only the last is found living. I have examined the animal of *Cr. radiata*, Chem., which I dredged in 2-4 fathoms near the island Penang, and in the Singapore harbour. Its anatomy agrees with that of *C. pulchra* given in Woodward's Manual. The similarity between it and *Astarte* is very great, but there is no special posterior anal opening in *Crassatella*; the rectum curves from above behind the posterior adductor, and the anus terminates freely into the open space, but the attachment of the two mantle margins in that place is very slight indeed and considerably stronger where their separation begins, which corresponds to the anal commissure in *Astarte*. Considering this distinction in the organisation of the animal, and the important character of the presence of an internal cartilage in the shell, I believe that there is sufficient reason to retain Gray's classification of *Crassatella* in a special family. H. and A. Adams place the genus in the *ASTARTIDÆ*.

The former view is also supported by the geological history of the group. We see comparatively only few species of *CRASSATELLIDÆ* represented in the mesozoic strata. The greatest variety of forms seem to have existed during the cretaceous period, their number increasing in the later part of that period rather rapidly, and being probably here the largest. It nearly reaches that of recent species during the eocene formation. The American cretaceous and tertiary deposits seem to be richer than those of Europe and of the East. In the miocene time the number of species known is as yet small; but to obtain an idea of the fauna of that period, we must await the results of the examination of the corresponding deposits in tropical countries. Of living species there are about thirty-six on record, all from sub-tropical and tropical seas.

1. *Pronoe*, Ag., 1843, (Act. Soc. Helvet. Lausanne, p. 304). Shell sub-trigonal, like an *Astarte* or *Cytherea*, with slight concentric striation on the surface; hinge of right valve with two cardinal teeth, the anterior one extending somewhat below and forming the margin of an elongated pit, above which there is a small sub-lunular tooth; a small oblique cartilage pit is situated just behind the beak and a large remote posterior lateral tooth is also present; fulcrum strongly thickened (vide Quenstedt, Jura, p. 319, pl. 44, fig. 1). The hinge of the left valve must possess two cardinal and one sub-lunular and one posterior double lateral tooth. Type, *Venulites triangularis*, Schloth., (*Cytherea idem*, apud Goldfuss), a liasic species. If Quenstedt's figure and description of the hinge of this species is correct, this would be the oldest form of *CRASSATELLIDÆ*, though, as that author remarks, the hinge-teeth of the right valve very much resemble those of a *Cyprina*; and should it be proved that the small pit is only an accidental depression in which a part of the external ligament is situated, the generic name would have to be

cancelled, and the species referred to *Cyprina*, with which the shell perfectly agrees in form. It was first described as *Venulites*, under which name Schlotheim made known a large number of fossil shells, externally resembling *Venus* (in the old sense of the term and rather applying to *Cytherea*, as restricted).

2. *Ptychomya*, Ag., 1842, (vide Pictet and Camp., Pal. Suisse, 4^{me} ser., p. 350). Shell ovately elongated, moderately compressed, beaks close together, placed sub-anteriorly, surface radiately ribbed, anteriorly generally divaricately striated; hinge with three diverging cardinal teeth in each valve, the posterior ones very elongated, double in the right valve, and the cartilage pit situated in front of them; muscular impressions elongately oval, rather large; pallial line truncate posteriorly. Type, *Pt. plana*, Ag., (*Crassatella Robinaldina*, d'Orb.).

Pictet and Campiche have pointed out the distinctions of this genus from *Crassatella*; they chiefly note the external differences in the ornamentation of the shells, but there is also a considerable difference in the arrangement of the hinge-teeth. The species of *Ptychomya* as yet known are few, and most of them appear to belong to the cretaceous period. Lycett named an oolitic shell, *Pt. Agassizi*, which I noticed under *Myochama* (p. 61).

Radioconcha, Con., 1869, (Am. Journ. Conch., v, p. 47,) is noted as "Compressed, inequilateral, radiated; hinge without a distinct cardinal pit. *C. Guérangeri*, d'Orbigny; *C. Robinaldina*, d'Orbigny." Such is the wonderful characteristic of one of Mr. Conrad's wonderful new genera! This almost amounts to an abuse, setting aside the disregard or neglect of the work of previous authors. The first species is a *Crassatella*, and has no radiating ribs; the second is the type of Agassiz' *Ptychomya*. What should be thought of Mr. Conrad's other genera of *CRASSATELLIDÆ*, if they are based upon similar principles? +

3. *Anthonya*, Gabb, 1864, (Pal. Calif., i, p. 181). Shell narrow, compressed, posteriorly very elongated, anteriorly shortly rounded, beaks obtusely pointed; hinge with two elongated, somewhat diverging cardinal teeth in each valve; a pit is seen posterior to them in both valves, and judging from the general resemblance of the shell to *Crassatella*, it is probably destined to receive a cartilage. Type, *A. cultriformis*, Gabb, from cretaceous deposits of California.

4. *Crassatella*, Lam., 1799. Shell elongately oval, compressed, or moderately tumid, inequilateral, posteriorly generally somewhat produced, beaks close together; hinge with two anterior elongated cardinal teeth in each valve, the cartilage pit posterior to them; a posterior sub-lateral tooth parallel to the hinge margin in the right valve, it fits into a corresponding marginal groove of the other valve, a more or less distinct elongated tooth being situated below it; the right valve usually also has a minute anterior lateral tooth and the left a corresponding small pit; muscular impressions roundly oval, posterior, as usually, larger than the anterior, and both are moderately excavated.

There are two somewhat distinct forms included in this genus. All the cretaceous and many eocene species have a rather high sub-triangular form, two large strongly diverging cardinal teeth in the left valve, the posterior tooth

Crassatella Lam. 1799. Shell elongately oval, compressed, or moderately tumid, inequilateral, posteriorly generally somewhat produced, beaks close together; hinge with two anterior elongated cardinal teeth in each valve, the cartilage pit posterior to them; a posterior sub-lateral tooth parallel to the hinge margin in the right valve, it fits into a corresponding marginal groove of the other valve, a more or less distinct elongated tooth being situated below it; the right valve usually also has a minute anterior lateral tooth and the left a corresponding small pit; muscular impressions roundly oval, posterior, as usually, larger than the anterior, and both are moderately excavated.

being directed backwards, the cartilage pit posterior to it small and very oblique, the posterior lateral tooth also small in the left, and almost obsolete in the right valve; the lunula is deeply excavated. The cretaceous *Crassatella macrodonta*, Sow., may be considered as the type of this section. Deshayes (Paris fossils) figures several eocene species. I do not know whether any of the recent species show a similarly strong divergence of the hinge-teeth, but their form is fully represented by such species as *C. kingicola*, Lam.

Most of the recent and many of the tertiary species of *Crassatella* have the cartilage pit rather large and almost perpendicular below the beaks, the cardinal tooth adjoining the pit in the left valve being smaller than the anterior tooth, while the reverse is the case in the older species just pointed out. The lunula is also only slightly or hardly at all excavated. I was first inclined to propose for the older forms a separate name, but I find among the eocene species so many middle forms that it would be impossible to define the division with any sufficient accuracy.

Mr. Conrad seems to have settled the question very rapidly; he proposes for d'Orbigny's *Crass. Vindinnensis* (non *Vindiemensis*), which is of the same type as *macrodonta*, the new generic name *Pachythærus*. I cannot see, as already stated, sufficient ground for this generic distinction, though the separation may suit Mr. Conrad's views better than those of any other conchologist, (see Am. Journ. Conch., v, p. 47). Another cretaceous form was called (ibid. p. 48) by the same author *Scambula*; its type is *S. perplana*, being in every respect similar to the recent *Crassatella radiata*, of which I have noted the description of the animal.

LIST OF CRETACEOUS SPECIES.

Ptychomya (see Pict. and Camp., Pal. Suisse, 4^{me} ser., 3^{me} part., p. 357).

1-3.—*Pt. Robinaldina*,* *Germani*, and *neocomiensis*.

4.—*Pandora æquivalvis*, Deshayes, (Mém. Soc. Géol., v, p. 4, pl. 3, fig. 7; *Crassatella idem*, d'Orb.), can hardly be a *Ptychomya*; there is no particular reason to be given why it could not be a *Pandora*, but it may possibly be an *Anthonya*, or perhaps a *Remondia* (*TRIGONIDÆ*).

5.—*Crassatella Cornueliana*, d'Orb., (Pal. franç. cret., iii, p. 74, &c.) is an *Anthonya*.

6-7.—*Ptych. solita*, d'Orb., sp., and *Pt. Buchiana*, Karsten, are from New Granada and Columbia.

8.—*Anthonya cultriformis*, Gabb, see p. 293.

Crassatella (see Pict. and Camp., l. cit., p. 346).

9-12.—*C. Saxoneti*, *Sabaudiana*, *Fiziana*, and *inornata* are all imperfectly known.

13.—*C. Gallienni* would rather seem to be a *Ptychomya* than a *Crassatella*.

14-30.—*Crassatella Guerangeri*, (? *Ptychomya*), *Ligeriensis*, *Vindinnensis*, (vide Guéranger, Album paléont. de la Sarthe, 1867, pl. xvi,) *sub-gibbosula*, *Neptuni*, *macrodonta*, *Austriaca*, *Marrotiana*, *orbicularis*, *Galloprovincialis*, *Normaniana*, *Dufrenoyi*, *arcacea*,† *rugosa*, *Bosquetiana*, *hellica*, *pisolithica*.

31.—*C. calceiformis*, Müller, (Pet. Aach. Kreidef. Suppl., 1859, p. 13, pl. vii, fig. 15,) is a rather elongated form, and may belong to *Anthonya*.

* See also *Crass. complicata*, Tate, (Quart. Journ. Geol. Soc., Lond., 1867, xxiii, p. 160,) from the so-called jurassic deposits of South Africa.

† *C. parallela*, Alth, vide *Trapezium*, No. 109, p. 195.

32.—*C. dædala*, Coq., Mon. Étage Aptien de l'Espagne, 1865, p. 127, is apparently a *Ptychomya*.

33.—*C. truncata*, Pusch, (Polens Pal., p. 77, pl. 8, fig. 3, and Eichwald Leth. ross., 10 livr., p. 638,) from white chalk.

34.—*C. taurica*, Eichwald, ibid., p. 638, pl. 24, fig. 6.

35.—*Crassatella borealis*, Eich., ibid. p. 640, figured by Keyserling Petschora-reise, pl. 17, figs. 23-24, simply under the generic name of *Crassatella*, is supposed by Eichwald to be more probably a neocomien than a jurassic species; but the form of the shell does not agree with a *Crassatella*; it may rather be a species of *Baroda* (sub-fam. *TAPESINÆ*), or perhaps some form of the sub-family *GARINÆ* (p. 113) or *PHARELLINÆ* (p. 36).

36-40.—*C. pusilla*, *Tenouklensis*, *Baudeti*, *Picteti*, and *Desvouxii* are described by Coquand in his Paléont. de la Prov. Constantine, (Algeria).

41-52.—*C. Alabamensis*, *cuneata*, *Delawarensis*, *Evansii*, *lintea*, *lineata*, *Monmouthensis*, *parvula*, *pteropsis*, *subplana*, *transversa*, and *vadosa* are recorded by Meek in Check-list of cretaceous fossils of North America, (Smiths. Misc. Coll., No. 177, 1864, p. 11).

53-57.—*C. grandis*, *compacta*, *Uvasana* are noticed from California by Gabb (Pal. Calif., ii, p. 244). In addition to these I may mention from Conrad's lower eocene (? cretaceous) beds *C. capricranium* and *palmula* (Smiths. Misc. Coll., No. 200, 1866, p. 5).

58-59.—*C. perlata* and *planata* of Conrad., (Am. Journ. Conch., ii, p. 104,) first noted from tertiary rocks are subsequently (Am. Journ. Conch., iii, p. 270,) stated to be cretaceous.

60.—*C. prora*, Con., Am. Journ. Conch., v, p. 43, is described from Crosswicks, New Jersey.

61.—*Crassatella perplana*, (*Scambula*, id., Con.), ibidem, p. 48, is noted from Haddonfield.

62-63.—*C. Rothii*, Fraas, and *C. Syriaca*, Con., (Würt. Nat. Jahreshefte, xxiii, p. 234,) are from Palæstine.

64.—*C. Zittelliana*, n. sp., and *C. macrodonta*, Sow., occur in the uppermost beds of our South Indian cretaceous deposits.

CRASSATELLA, Lam., 1799, (see p. 293).

1. CRASSATELLA MACRODONTA, Sow., sp., Pl. V, Figs. 12-14.

1832. *Astarte macrodonta*, Sow., Trans., Geol. Soc., London, iii, p. 417, pl. 38, fig. 3.

1865. *Crassatella idem*, Zittel, Denksch. Akad., Wien, xxiv, pl. ii, p. 150,—*cum synonymis*.

*Cr. testa elongato-trigonata, inæquilaterali, antice breviter rotundata, postice longiore et oblique truncata, margine subumbonali leviter insinuato, postico declivi, marg. inferiore postice flexuose curvato instructa, moderate inflata, carina obtusa ab umbonibus ad marginem postero-inferiorem maxime productum decurrente; lunula areaque profundis, prima brevior quam altera sed latiore; superficie in speciminibus junioribus semper concentricè costulata, in adultis aut æqualiter crasse costulata,—costulis in declivitate postica obsoletis (var. *sulcifera* auctore Zittel),—aut minute striata; cardine dentibus duobus cardinalibus in utraque valva et fossa cartilaginigera profunda instructo, dentibus anterioribus multo fortioribus quam posterioribus, omnibus compressis; dentibus lateralibus anticis parvis, dente postico laterali in valva sinistra obtuso, elongato, in v. dextra fere obsoleto; margine interno denticulato.*

Length of shell	:	its height	...	...	...	0.84 - 0.90
Thickness	„	:	„	...	...	0.60 - 0.65

The persistency with which the two forms, one strongly concentrically sulcated and the other only finely striated, occur together is very remarkable; passages

from one to the other can, however, be traced in India as well as in Europe. The form of the shell and its thickness is subject to a great deal of variation, as may be seen by a comparison of our figures, and still more those given by Zittel. The strongly sulcated form is designated by Zittel as *var. sulcifera*. I can see no difference in his figures between the hinge of this variety and that of the typical form; we possess three left valves of the former from Southern India, and one left and two right ones of the latter. Comparing these together the hinge area of *var. sulcifera* is higher, the teeth longer, and the lunula deeper than in the three specimens of the typical form; but as the shells do not differ in any other respect, I am inclined to regard with Zittel the variation to be within the limit of specific character.

Locality.—Near Arrialoore, in grey soft sandstone; not common.

Formation.—Arrialoore group.

2. CRASSATELLA ZITTELIANA, *Stoliczka*, Pl. V, Figs. 15-19.

Cr. testa cuneiforme elongata, inæquilaterali, tumida, ad marginem lunularem emarginata, antice breviter rotundata, postice attenuata, sub-caudata et oblique truncata, carina acuta ab umbonibus ad terminationem postero-inferiorem decurrente instructa, concentrice costulata, costulis in regione umbonali crassis, peripheriam versus tenuioribus, confertis, postice fere omnino obsoletis; lunula elongato ovali, profunda, lævigata, margine acuto circumscripta; area longiore, angusta etiamque profunda. Cardine dentibus cardinalibus anterioribus in utraque valva et fossa cartilaginifera postica mediocriter excavata instructo, dente antico in valva dextra laterali approximato, postico fere omnino obsoleto; in valva sinistra dente laterali antico parvulo, postico elongato, distinctiore.

Height of shell	:	its length	...	...	...	...	0.74
Thickness	„	„	...	...	...	...	0.64

The ornamentation of this species is, as likewise its peculiar pholadoid form, very characteristic, strongly recalling the palæozoic shells which have been called *Sedgwickia*. Near the umbones the concentric ribs are strong and angular, as in most species of *Gouldia*, to which the species, when young, bears a great resemblance; on the greater convexity of the sides of the shell the ribs gradually decrease in thickness, but increase in number; they remain tolerably distinct on the anterior part of the shell, on the posterior they, however, soon disappear altogether, and are replaced by mere fine striæ of growth.

Locality.—Ninnyoor, in white limestone; not common.

Formation.—Arrialoore group.

VII. Order,—UNIONACEA.

I will class in this order all the fresh-water Pelecypoda which are generally known under the name of *Unio*, besides those few remarkable, partially adherent, species, called *Ætheria*, and its allies. All these shells agree with each other in many important characters, they being always covered with an olivaceous more or less thickened epidermis, pearly inside, with an external, or partially sub-internal ligament, with two muscular scars (only in *Mülleria* the anterior becomes obsolete with advanced age), and an entire pallial sinus. Generally there is a small supplementary muscular scar behind or below the anterior one, and sometimes partially confluent with it; it is produced by a particular muscle which I shall describe in the *UNIONIDÆ*. The hinge has either no teeth at all, or only a set of anterior teeth, or there are anterior and posterior teeth present. These hinge-teeth are always of a peculiar construction, and I think the term "lateral teeth," as used by Jeffreys in his *British Conchology* (vol. i, p. 28,) is more correctly applicable to them than the term cardinals, which generally is reserved only for the anterior teeth. There is, however, a free interspace in the place of the true cardinals to be observed between the two series of teeth, and consequently the anterior teeth are quite equivalent to the posterior, and both should be called laterals. This especially becomes apparent when we compare forms like *Castalia* and similar genera.

The animals of the *UNIONACEA* mostly are closely allied to those of the *ASTARTIDÆ*. All have a widely disunited mantle, but some possess a single anal opening, this form including apparently the typical section; others are said to possess two siphonal openings, and again some other externally allied forms have no special siphonal openings. Thus we find a repetition of the same variations which I noticed in the *LUCINACEA* regarding this point. There are two pairs of gills and two of palps in all genera; the foot is generally sub-trigonal, wedge-shaped, rarely elongated and thickened at the end.

Following H. and A. Adams' arrangement in this group of Pelecypoda, I shall retain his two families *UNIONIDÆ* and *MUTELIDÆ*; in the first the animal possessing only one, in the second two siphons. If this distinction in the animals exists the classification has good ground, whatever astonishingly absurd Deshayes may find in it; but I do not wish to be answerable for it, as I had no opportunity to examine any of the animals of the second family. Besides these two I shall treat in this order also the *ÆTHERIIDÆ*. Only the first family has as yet some palæontological importance for us.

XXX. Family,—UNIONIDÆ.

I take as an example of the organisation of this family the following description from two of our common Bengal species, *U. marginalis*, Lam., and *U. cæruleus*, Lea. Body oval, with a large laterally compressed foot, obtusely sharpened at the edge and more or less produced in front, strongly extensible, mantle entire, disunited all round with only a small anal opening, being separated by a very thin commissure from the inhalant portion; the edges of the latter are strongly

ciliated, those of the anal opening are slightly extensible, and finely ciliated; labial palps two on each side, long (about $\frac{1}{4}$, or slightly less than the body), very narrow, and linear in front and united above the mantle, broader and sub-triangular posteriorly, attached along the dorsal line only, but free with the hinder portions; one pair of gills* on each side, the outer smaller than the inner, both entirely free, only attached along the upper or dorsal line, and in continuation of this attachment lies the commissure which separates the exhalant opening from the inhalant region; the length of the gills is about equal to $\frac{3}{4}$ th the length of the body, or it is somewhat less. Each gill consists of a large number of fillets, which are of two kinds, longitudinal and transverse. On the upper portion of the gills the first are stronger, being at moderate distances, intersected by vertical grooves; towards the edges of the gills the fine transverse striation becomes the more distinct one. Retractable muscles strong; a thin muscle originates at the anterior end of the gills, continues anteriorly, becoming at the same time thicker, and terminates at the anterior part of the palps; it is with the lower edge partially united to the anterior muscular impression, and it is the muscle which produces the supplementary small scar generally situated behind the large anterior one, and is occasionally more or less confluent with it. This supplementary muscle appears to have the object of producing a harmonious movement in the gills with the palps. The visceral cavity did not offer any peculiarity; the rectum lies, as usually, along the upper posterior edge and terminates in the exhalant opening. The posterior lower portion of the body was in two specimens entirely filled with undeveloped eggs.

This description of the animal seems with very slight alterations to apply to all the typical species of *UNIONINÆ* of H. and A. Adams, but in the American genus *Mycetopus* the authors note some very marked differences. It would appear from their description that there is no separate anal opening, as is, for instance, the case in *Crassatella*; the outer branchiæ are said to be entirely grown together. The foot is very long and cylindrical with a thickened knob at the end. It is evidently intended for boring in mud, similar to the same organ in the *SOLENIDÆ*, which use it by extending the thickened end into a point, then twist it round with a forward pressure, thus making a hollow as if executed with a borer, then expanding the end of the foot with force, so as to give it proper hold in the hollow made, after which the foot itself is contracted, and the whole animal advances in the direction where the hollow was made. I have little doubt that the *Mycetopi* and their allies use their club-shaped foot in a similar manner. The *Uniones* use their foot more for digging or making superficial furrows, forcing the removal of the mud by lateral pressure. Considering the above noted differences which are unquestionably very important, H. and A. Adams propose for that genus a special sub-family, *MYCETOPINÆ*.

* In most of the specimens of *U. marginalis* I found (in June) on the gills a pair of a very remarkable parasitic *Arachnoid*, belonging to the order *Colopoda*, resembling in form *Ixodes*, but possessing only two distant ocelli in front. I shall take an early opportunity of describing these apparently very interesting animals.

The shells of the *UNIONIDÆ* are extremely variable as to form and thickness; all stages from ovately rounded into ovate and linearly elongated, or rectangular and trapezoidal shapes, are to be met with. The solidity of shells varies equally as the size, and often depends upon the character of the locality where the animals live. The hinge has either an anterior and one posterior tooth in each valve, or only the anterior are present, or both are absent; the ligament is moderately strong and supported by fulcra; muscular impressions two.

As regards geographical distribution the *UNIONIDÆ* are world-wide; they are almost everywhere present where permanent fresh-water pools or rivers occur, though they are to be met with in greatest numbers and variety in the American, especially North American, rivers. There the recent species form quite a contrast to the insignificantly small number of tertiary forms as yet on record. But also in other countries fossil *Uniones* are a great rarity, for true fresh-water deposits do not appear to have been very extensive in any of the former geological formations. Eastern Europe was during the latter part of the miocene period ("Sarmatische Stufe") inhabited by a comparatively large number of *Uniones*, some of which greatly resemble North American types (see Hörnes' Foss. Mollusken des Wiener Beckens, vol. ii). From the German miocæne and oligocæne deposits only very few are known, and India, during the Sivalik deposits, was also peopled only with a small number of species. From the eocene deposits of the Paris basin Deshayes describes only five species. Of cretaceous forms I may say there are only two with sufficient certainty known from Europe; two are doubtful, but ten supposed new forms have lately been added from North America (New Jersey).

The first typical forms of *Unio* appear in the so-called Wealden deposits of North Germany and England; the forms partially represent true *Unio*, partially *Margaritana*. From the carboniferous beds I add two genera, but it yet remains to be proved that their classification in this place is correct.

The generic divisions which I adopt here are mostly those recorded by H. and A. Adams. These genera are unquestionably as good as any others which have been proposed in other families, but I do not enter into the sub-generic divisions, there being no occasion to discuss those details here. I do not see any benefit in arguing the great unity of the genus *Unio*, for Deshayes seems to have exhausted the subject, though, as the result of all his arguments, he at last finds it necessary to describe two of the Paris species as *Anodonta* and three as *Unio*! Deshayes places also *Cardinia*, Ag., in the present family, but I do not think that there can be much difference in the opinions of other conchologists regarding the classification of this genus, for it agrees in all essential characters with the *ASTARTIDÆ*, where it has been recorded.

a. Sub-family,—*UNIONINÆ*.

1. *Carbonicola*, M^cCoy, 1855, (Brit. Pal. Rocks and Foss., p. 514). Shell elongated, solid, with moderately tumescent, not eroded, beaks, somewhat impressed in front of them; ligament strong external; surface concentrically striated;

hinge with one very thick cardinal tooth in the right valve, extending posteriorly, with one long anterior and one long posterior lateral tooth; muscular scars one on either side, each surmounted by a small accessory impression; type, *Carb. acuta*, Sow.

This would appear to be the oldest form of *UNIONACEA*; the lateral teeth of the right valve (the only one as yet upon record) closely resemble those of *Unio*, but the presence of a large separate cardinal tooth makes this classification somewhat doubtful, for all the genera of this order seem to possess only one kind of hinge-teeth, may they be called either cardinal or lateral teeth. Another difference rests in the small impressions above the muscular scars, a character which is very commonly met with in species of the *ASTARTIDÆ* (*Cardinia*, *Astarte*, &c.), but not in any genus belonging to the present order. However, as these fossil shells have not as yet been satisfactorily examined, the present classification may be equally correct as any other I could suggest. I have no good specimens for examination, and can, therefore, add nothing to the characteristic as at present recorded. M^cCoy says that there are about twenty species in the coal-measures "associated exclusively with fresh-water and terrestrial remains." Certainly there can no reasonable doubt be entertained why the fresh-waters should not have been populated during the time of the carboniferous deposits with *UNIONIDÆ* when other much higher organised animals lived in them, and again others on the surrounding dry land.

In external appearance *Carbonicola* greatly resembles *Anthracosia*, which I may also have classed here but for reasons which will be found stated in the family *SAXICAVIDÆ* (see p. 86).

X 2. *Prisconaia*, Conrad, 1867, (Am. Journ. Conch., iii, p. 10). Shell ovate; hinge in the left valve with two cardinal teeth, the anterior compressed, angular, oblique, with an anterior pit; the posterior broad, smooth, convex, triangular, situated under the beak and directed posteriorly, emarginated at its end; no lateral teeth, muscular impressions situated near the cardinal line; type, *P. ventricosa*, Con., from carboniferous beds in Kansas, North America.

This genus, Conrad says, bears the same relation to *Carbonicola* that *Margaritana* bears to *Unio*. The teeth certainly have in this case the form of true cardinals, for they are very close to each other below the beak, but there are no other teeth in the hinge, and the anterior muscular scar is quite adjacent to the anterior cardinal. There is, therefore, less objection against the classification of this genus in the present family, than has been stated in the previous case. X

3. *Unio*, Philipsson, 1788. Shell generally ovately elongated, sometimes sub-trigonal or rectangular, moderately tumid and of rather solid structure; anterior hinge-tooth double or of irregular shape, the lamella being either simple or more or less corrugated and denticulated; posterior tooth elongated, single in the right, double in the left valve; type, *U. pictorum*, Linn.

The desirability of classifying the very numerous recent species of *Unio* in sub-divisions or sections, and the difficulty experienced in doing this, has been

X Nevertheless, it has no relations to the Unionidae, but is very closely allied to *Schizodus*, King, if not really only a section of that genus; and consequently a member of the family *Schizodidae*!

so often made an object of complaint by conchologists that I do not need to repeat it here. None of the sub-divisions as yet suggested can be called satisfactory, and I am constrained to say that the attempts to make them so are not likely to be very successful. The sub-divisions, if they were to be of any use and convenience for the grouping of these shells, must principally be based upon the mere external form or shape, and the general modification of the hinge-teeth as dependent on that form. The form, or rather the position of the supplementary anterior muscular scar, seems in some groups to remain tolerably constant. H. and A. Adams (Genera ii, p. 490,) recognise the following sub-genera—*Bariosta*, Raf., *Naidea*, Swains., *Obovaria*, Raf., *Niäa*, Swains., *Hyridella*, Swains., *Lampsilis*, Raf., *Canthyria*, Swains., *Iridea*, Swains., *Rotundaria*, Raf., *Quadrula*, Raf., *Diplodon*, Spix, *Dysnomia*, Ag., *Plagiodon* (l. cit., p. 651), and *Metaptera*, Raf. Conrad quotes from the eocene deposits of North America a sub-genus *Uniomeris* (vide Smiths. Misc. Coll., No. 200, 1866, p. 5). A peculiar fossil form will also be indicated in the list of cretaceous species.

4. *Margaritana*,* Schuhm., 1817. Shell oblong, moderately compressed; hinge with a single erect tubercular anterior (cardinal) tooth in the right valve, double in the left, the anterior half being smaller than the posterior, which is often denticulated or slightly rugose, but all the teeth are covered with enamel like the rest of the interior of the shell; posterior hinge-teeth more or less obsolete. Type, *M. margaritifera*, Linn.

H. and A. Adams regard the following as sub-genera of the above:—*Elasmodonta*, Say, (? = *Elasmodon*), *Complanaria*, Swains., and *Uniopsis*, Swains., (= *Calceola*, Swains., non Lam.). *Margaritana* differs from *Unio* by the want of the posterior hinge-teeth; they are not developed in any of the known species, and if indicated it is only by a peculiar thickening of the hinge margin, very distinct from what is seen in *Unio* proper.

5. *Monocondylæa*, d'Orb., 1835. Shell sub-rotundate or oblong, hinge-teeth represented by one anterior tooth in each valve, the one in the right valve being under or posterior to the beak, the other in the left valve anterior to it; the teeth are elongated in the direction of the hinge margin, and the region in front of the beaks is bent in and partially filled with the ligament, posterior teeth obsolete; type, *M. Paraguayana*, d'Orb.

American conchologists have certainly not shown less anxiety in the discovery of new genera and species in the Indian regions, than they do in their own country.

5 a. Gould, in 1844, suggested for some Burmese and Malayan species the name *Pseudodon*, of which his *Ps. Salwinianus*,—bearly distinguishable from *Monocondylæa Peguensis*, Anthony, (Am. Journ. Conch., 1865, i, 205, non *Unio Peguensis*, Anthony, also from Burmah)—is a typical species. In this and other allied forms the teeth are quite of the same peculiar character, being more or

* I do not think that Meuschen's name *Baphia* has any claim of priority before *Margaritana*; I do not find that it possessed any restricted signification before the introduction of the latter name.

less parallel to the hinge margin, as in the South American *Monocondylææ*. But the hinge-tooth of the right valve fits into an emargination situated in front of the beak of the left valve, while the tooth itself of this latter valve is below the beak.* In typical *Monocondylææ*, as characterized by d'Orbigny, the tooth of the right valve catches behind that of the left, but d'Orbigny adds, the reverse is occasionally the case. I have unfortunately no series of South American *Monocondylææ* to compare, but if this be really the case, I cannot see in which characters *Pseudodon*† should differ from *Monocondylææ*, except perhaps that the Burmese and Malayan species composing it are more of a trapezoid than rounded shape, and are more compressed than the American forms.

5 b. For another Burmese species, described by Anthony in Am. Journ. Conch., i, p. 205, as *Monoc. crebristriata*, Conrad proposed (ibid. p. 233) the name *Trigonodon*. The hinge of this species has in the right valve an erect almost vertically or obliquely elongated tooth fitting into a divided tooth of the left valve, the posterior portion of the left tooth being much larger than the anterior. The hinge is perfectly the same as in *Monoc.* (or *Pseudodon*) *Euphratica*, Bourg., from Syria and America, and I cannot perceive any difference between it and *Margaritana*. I have also examined the animal of the so-called *Monoc. crebristriata*, and I find there is no difference between it and the last genus, as I had already occasion to state.

5 c. For another species again, *Monoc. Mardinensis*, Lea, from the River Tigris, Conrad proposed, 1865, the generic name *Leguminaia* (Am. Journ. Conch., i, p. 233). Conrad says that it "has an outline approaching *Marg. margaritifera*, being medially contracted and of an oblong and leguminous shape. The cardinal tooth is pyramidal and recurved, wholly unlike the transverse compressed tooth of *Pseudodon*." I received a specimen from the River Tigris through Mr. G. Nevill, and this well agrees with Mr. Conrad's account. In another specimen in Mr. Nevill's collection from the same locality the tooth is somewhat less prominent, and in both extremely like, or I should rather say identical with, that of *Margaritana*.

Large series of all these shells in different stages of growth must be examined, for there is no doubt that they gradually pass one into the other, and connect *Margaritana* with *Unio*. Certainly nothing can be more unnatural than creating new generic groups upon the examination of single shells,—particularly among such most variable forms as the fresh-water *UNIONIDÆ* are known to be,—and then attempting to assimilate the various species to the imaginary characteristics. It is just the contrary way, we have to take in a natural classification.

6. *Gonidea*, Conrad, 1857, (Proc. Acad. Nat. Sc., Phil., p. 165). Shell "elongated, hinge furnished with a short, obtuse cardinal tooth, fitting into a corresponding depression in the cardinal plate; tooth obsolete in the left valve;

* Conrad's account (Am. Journ. Conch., i, p. 232,) is unintelligible on this point.

† Some of the old fossil-species externally very closely resemble this type of *UNIONIDÆ*, such species, for instance, as the Wealden *Unio Menkei*, Dunk., Wealden-Bildung, 1846, p. 28, pl. xi, figs. 1-3.

anterior muscular impressions not confluent, lower accessory impressions opposite the middle of the large impression;" type, *Anodonta feminalis*, Gould, from North America.

I do not know whether this form is sufficiently distinct from *Anodonta*, for even in some of the well marked European species there is a rudiment of a tooth below the beak of the left valve.

7. *Barbala*,* Humph., 1797. Shell moderately compressed, thin, with the posterior dorsal margins generally somewhat extended wing-like, hinge with a single linear tooth extending through the whole hinge margin, not interrupted below the beaks, in other respects not differing from *Unio*: type, *B. plicata*, Humph.

8. *Anodonta*,† Cuv., 1798. Shell elongated, moderately inflated, or sub-trapezoidal and then generally more compressed; hinge without teeth, sometimes with a small sub-obsolete lamina under the beak of the left valve; type, *A. cygnea*, Linn.

H. and A. Adams quote *Symphynota*, Lea, *Lamproscapha*, and *Patularia* of Swainson as sub-genera.

9. *Byssanodonta*, d'Orb., 1846. Shell elongately rounded, inequilateral, thin, beaks sub-anterior, moderately tumescent, hinge edentulous. H. and A. Adams give a description of the anterior hinge-teeth as being double in both valves and the posterior rather elongated; it would appear that the reference had been taken from *Unio Paranensis*, Lea, but not from the true type *B. Paranensis*, d'Orb.

b. *Sub-family*,—MYCETOPINÆ.

I have already noticed the circumstances under which this sub-family is here retained.

10. *Mycetopus*, d'Orb., 1835. Shell much elongated; distinctly gaping in front and somewhat less behind, sub-equilateral or inequilateral, the anterior portion being the shorter one; hinge edentulous; type, *M. soleniformis*, d'Orb.

10 a. The typical species are from South America. Very few are known from other countries. Hanley in Reeve's Conch. Icon., vol. xvi, refers to it also *Unio emarginata*, Lea, from Siam. A second allied species is from Eastern Cachar rivers, *Anodonta soleniformis*, Benson. The shell does not differ from the inequilateral forms of *Mycetopus*, but the animal has not as yet been observed. Should it prove to resemble that of *Mycetopus*, what does not appear improbable on account of the strong anterior gape, it would be one more proof of the admixture of a South American form in the fauna of Eastern Bengal and Burma. I think d'Orbigny's name was published in 1835, and Benson's

* Though I admit that, as a rule, Humphrey's names have no claim to priority, it does not appear to be so in this case. The name was very early introduced by Deshayes, Sowerby, and others, and the type species which Humphrey called *B. plicata* well known. Leach's name *Dipsas*, used by d'Archiac and other palæontologists, has no priority and was already bestowed upon a snake.

† There is no doubt that Lamarck's name is only a correction of Cuvier's original *Anodontite*.

in 1836, in Asiatic Society's Journal, v, p. 750; consequently the latter will have probably to be changed. Conrad (in Journ. Am. Conch., iv, p. 249,) proposes for *Mycetopus emarginatus*, Lea, the generic name *Solenaia* with the following characteristic—"elongated, thin, gaping anteriorly, hinge with a long acicular lateral tooth in each valve, slightly developed." I have not seen the Siam species, but the Cachar *Anodonta soleniformis* of Benson, which is very closely allied to the former, has no lateral teeth.

LIST OF CRETACEOUS SPECIES OF *UNIONIDÆ*.

1.—*Unio Cornueliana*, d'Orb., Prod. ii, p. 106, (*U. Martini*, Pal. franç., cret., vol. iii, p. 127, pl. 284, non *idem*, Sow. apud Fitton). In his figure of a cast specimen d'Orbigny does not show any distinct trace of the existence of a posterior tooth, but there are two unequal sub-anterior in the left valve, the anterior being very large, the posterior very small; this kind of hinge, if correct, would indicate the species to belong to *Margaritana*. D'Orbigny first identified this species with one from the Wealden beds, but then separated it as distinct, which, judging from figures only, certainly appears to be more correct; it is from the so-called Urgonien or Upper Neocomien.

2.—*Unio creataceus*, Zittel, (Denksch. Akad., Wien, xxiv, pt. ii, p. 158). I have not seen the hinge of this species, and I am not certain whether it is quite correctly figured by Zittel. The species exhibits two unequal anterior teeth, or rather a large bifid tooth, its anterior portion being smaller than the posterior, and there is only a single elongated rather thin posterior tooth; besides that the anterior muscular scar is situated on a raised lamina. In all species of *Unio* the posterior tooth of the left valve is double and the one of the right usually single. The form of the anterior teeth varies almost *ad infinitum*. It is probable that this cretaceous species has to be separated into a distinct genus, but better materials are required for that purpose than those now accessible. The species is from the Alpine-Gosau formation, (*Turonien*).

3.—*Unio acutus*, Schafhäutl (Süd-Bayerns Leth. Geog., 1863, p. 163). A small form resembling a *Cardinia*; the hinge-teeth are not observable, and the generic determination, therefore, doubtful. The author quotes it from a locality from which in other places he describes cretaceous shells, but whether the present species is really a cretaceous form no one could guarantee.

4.—*Unio Nordmanni*, Eichw., (Leth. ross., x livr., p. 609,) is stated to be from a white chalk of the Crimea. The figure representing the species is peculiarly ovate and tumid, but hardly any one could suspect a *Unio* in it.

5-14.—Lea (Proc. Acad. Nat. Sc., Phil., 1868, No. 3, p. 162,) describes from some fresh-water cretaceous beds of New Jersey the following ten species, based upon a material consisting of about forty cast specimens collected by Prof. Cope:—*Unio nasutoides*, *radiatoides*, *sub-rotundoides*, *carriosooides*, *humerooides*, *Roanokoides*, *ligamentinoides*, *alatooides*, *Anadonta grandiooides*, and *corpulentoides*. The author cautiously remarks that the descriptions must necessarily be imperfect, being taken only from casts. He also states that they strongly recall the forms found by Mantell and others in Wealden deposits of England. Certainly, whoever will succeed hereafter in recognising Mr. Lea's species may call himself an unusually successful discriminator of fossils.

15.—*U. penultimus*, Gabb, Pal. Calif., i, p. 182, from the Tejon group of California.

16.—*U. Hubbardii*, Gabb, Pal. Calif., ii, p. 190, from the so-called Chico group of Vancouver Island.

D'Orbigny referred (in Prod. ii, p. 79,) all the species (seven) described by Sowerby* from the Wealden beds of England to his lower Neocomien, but at the time of writing he does not appear to have been acquainted with Dunker's "Monographie der Norddeutschen Wealdenbildung," &c. Geologists have up to the present not agreed upon the classification of the Wealden deposits, but it seems more conformable with the facts observed in nature, that the Wealden locally indicates the close of the jurassic period, than the beginning of a fresh series of marine deposits.

XXXI. *Family*,—*MUTELIDÆ*.

The labial palps of the animals are stated by H. and A. Adams to be large, oval, attached by their straight edges without any free points, as in *UNIONIDÆ*; the mantle-lobes united posteriorly, and prolonged into two short, unequal siphonal tubes; gills large, nearly equal, united to the body; the foot large, thick, compressed, tongue-shaped, angular in front. The shells are sub-quadrangular or elongated, often with wing-like extended upper margins, the hinge being straight with numerous denticulations, or they are oval, and then generally rather solid, resembling *Trigonia*, to which the hinge-teeth also bear some relation, although in their distribution they are more similar to those of *Unio*.

Looking at the above noted characters of the shells referred to this family, as compared with the *UNIONIDÆ*, one cannot hesitate in accepting H. and A. Adams' classification, but if the statement regarding the differences pointed out between them and the last family is not generally correct, the distinction of the two families can hardly be retained. I have unfortunately no materials whatever to test the accuracy of the statement, and therefore accept the family as it stands in H. and A. Adams' work. The species are mostly African and South American. I do not know any fossil species belonging to it.

1. *Mutela*, Scopoli, 1777, (*Iridina*, Lam., 1819). Shell very elongated, inequilateral, the anterior portion being much shorter than the posterior, thin; hinge line thin, nearly straight, as long or very nearly as long as the shell, crenulated or tuberculated along its entire length or only partially; type, *M. elongata*, Sow., from the Senegal. Hanley describes in Reeve's Conch. Icon., vol. xvi, five species, all from Africa. H. and A. Adams accept for *M. Nilotica*, Fér., as type, Swainson's name *Calliscapha* as sub-genus, that species having the hinge margin crenated only partially near the beaks.

2. *Pleiodon*, Conrad, 1835. Shell sub-trapezoidal or elongated, rather solid, inequilateral, the anterior side being somewhat shorter, hinge line flattened, somewhat shorter than the shell, and with numerous irregular plications or teeth; surface covered with a smooth thick epidermis; type, *Pl. ovatus*, Swains. Hanley (Reeve's Conch. Icon., vol. xvi,) describes only one other species, *Pl. Spekei*, Woodw.; both are from Central Africa.

3. *Spatha*, Lea, 1838. Shell elongated, thin, inequilateral, with the upper posterior edge somewhat expanded; hinge line slightly arcuate, toothless; type, *Sp. rubens*, Lam., from the Senegal; two other species are also from Africa.

* See his Min. Conch. and Trans., Geol. Soc., London, 2nd series, vol. iv.

4. *Leila*, Gray, 1842. Elongated, thin, inequilateral, with the beaks somewhat tumid; hinge line straight, edentulous; type, *L. Blainvilliana*, Lea, from South America, wherefrom also two other species are quoted.

The shells of these two last named genera are in form almost identical with some of the species of *Anodonta*.

5. *Triquetra*, Klein, 1753, (*Hyria*, Lam., 1819). Shell sub-trigonal, inequilateral, the dorsal edge of the hinge-line being more or less straight and prolonged into a wing on either side, and generally somewhat longer than the shell itself, which is of rather a solid structure; hinge-teeth elongated, similar to those of *Unio*, but strongly crenated or grooved, two anterior and one posterior in the left valve, the reverse being the case in the right valve; surface smooth or corrugated; type, *T. subviridis*, Klein. Hanley (in Reeve's Conch. Icon.) describes twelve species from South America.

6. *Arconaia*, Conrad, 1865, (Am. Journ. Conch., i, p. 234). Shell very elongated, somewhat contorted, solid; dorsal edge of the hinge line straight or nearly straight, shorter than the shell and slightly winged; hinge with anterior robust, short, and finely rugose teeth in each valve, posterior teeth elongated and minutely rugosely striated. As the type of this genus Conrad quotes *Triquetra lanceolata*, Lea, from China, being the same as *T. contorta*, Lea, described in Reeve's Conch. Icon. under the genus *Hyria*. The distinction from this last genus is only based upon the somewhat different shape of the shell and the presence of two anterior teeth in both valves; these are very variable characters, and it yet remains to be proved whether a generic importance can be assigned to them.

7. *Castalia*, Lam., 1819. Shell ovoid or sub-trapezoid, solid, tumescent, with incurved beaks, inequilateral; hinge line curved; hinge with two unequal anterior and one strong elongated posterior tooth in the left valve, the opposite being the case in the right one, all are transversally striated; generally there are also one or two small tubercular teeth below the umbones, more or less distinctly separated from the anterior teeth; type, *C. ambigua*, Lam. Hanley describes in Reeve's Conch. Icon thirteen species, mostly from America. Mousson in Mal. Blätter, xvi, p. 185, notes an additional one, *C. ecarinata*.

XXXII. Family,—*ÆTHERIIDÆ*.

The animal of *Ætheria*, constituting the type of this family, possesses a large, thick, oblong body; the labial palps are large, semioval, attached by the straight sides; the mantle-lobes are disunited; the two gills on each side are partially attached to the body and mantle, and united posteriorly. The foot appears to be small in the young animal, but it becomes obsolete with advancing age. The shells when young are free, of an elongately high ovate shape; when adult, attached with one valve and of an irregular form; the hinge is edentulous and the ligament sub-internal; surface covered with an olivaceous epidermis, more or less foliaceous; pearly within. There are no fossil species known belonging to this family.

1. *Ætheria*, Lam., 1808. Shell higher than broad, attached with the lower valve near the beak, upper valve somewhat smaller; ligament tortuous, partially stuck in a groove of the areal margin of the left or attached valve; muscular impressions two, wide apart, the anterior very long and irregular; type, *Æ. semi-lunata*, Lam., which is, as likewise the other two or three known species, from Africa.

2. *Mülleria*, Fér., 1823. Shell free, inequilateral, equivalve and thin, when young, with a thin ligament and two muscular scars; when adult, the beaks of the lower, partially attached, valve become considerably produced, while the upper or right valve remains smaller; the anterior muscular scar becomes obsolete and the pallial impression quite indistinct; type, *M. lobata*, Fér., is the only known species from South America.

3. *Bartlettia*, H. Ad., 1866, (Proc. Zool. Soc., Lond., 444). Shell free, equivalve, closed, inequilateral, the anterior portion being peculiarly produced and rugose, the ventral edge insinuated, hinge edentulous; ligament marginal, partially internal, supported by strong fulcra, muscular scars two, marginal; pallial line entire; type, *Bart. Stefanensis*, Moricand, from the Amazon river, originally described as *Ætheria*.

VIII. Order,—ARCACEA.

The families belonging to this order are four, *TRIGONIIDÆ*, *NUCULANIDÆ*, *NUCULIDÆ* and *ARCIDÆ*. They represent, though not without exception, the type of dimyarian Pelecypoda without any special in- or ex-halent siphons. The *NUCULANIDÆ* appear to be the most highly organized, possessing two more or less prolonged and united siphons; the animals of all the other families have, however, no trace of siphons, the mantle margins being open all round; there are always two retractile muscles present, a pair of gills and a pair of palpi on each side. In the *TRIGONIIDÆ* we find for the first time the existence of certain ocelli at the edge of the mantle, such as we see greatly developed in the *PECTINIDÆ*.

The shells have one character in common, consisting in the numerous denticulations of the hinge-teeth. The *TRIGONIIDÆ* indicate a great relation to the *CRASSATELLIDÆ*, possessing hinge-teeth somewhat similarly arranged as in these. The older forms (*Schizodus* and *Myophoria*) have them almost entire, like other *ASTARTIDÆ*, but *Trigonia* and its allies have them striated or denticulated. The three other families agree in the numerous denticulations of the cardinal margins. I do not think that these denticulations or plications can, strictly speaking, be compared with the crenated or denticulated hinge-teeth of *Spisula* or any other genus of the Pelecypoda. For in these the hinge-teeth actually fit beside or into each other, as they also do in *Trigonia*, one tooth being in this genus single, the other bifid. In the *NUCULANIDÆ*, *NUCULIDÆ*, and *ARCIDÆ* the hinge margins, or, as Gray calls them, hinge-teeth, fit exactly one on or against the other by a great number of small teeth or folds. This character is peculiar to the three mentioned families, and we only find it again partially indicated and somewhat modified in the *AVICULIDÆ*.

Other characters will be seen specified under the heads of the different families. I may only notice that in the same manner, as the *TRIGONIIDÆ* on the one side connect this order with the *ASTARTIDÆ*, so do the mytiliform species of *Barbatia* and its allies, (especially characteristic in the eocene), indicate a transition to the next order, the *MYTILACEA*.

In a geological point of view, the *ARCACEA* are an important order, for of the four families every one is represented already in the Silurian deposits, but their greatest development falls into different periods; that of the *TRIGONIIDÆ* into the jurassic, that of the *ARCIDÆ* in the cretaceous, and that of the *NUCULANIDÆ* and *NUCULIDÆ* either in the tertiary or in the present epoch.

The number of recent species belonging to the order is,—even supposing considerable additions have been made recently—, barely 400, while that of the fossil species is at least three times as large.

XXXIII. Family,—*TRIGONIIDÆ*.

The animals of *Trigonia* (group *Pectinatae*, see p. 311), have the mantle-margins entirely open and fringed, the edges between each of the larger papillæ being provided with small capsules, which appear to be eyes,* resembling those of *Pecten*; the foot is rather large, geniculate, somewhat expanded, anteriorly produced and with slightly serrated edges, some lateral grooves on it have been suggested as representing byssal grooves, but no byssus has been observed; the palpi are small, two on each side, somewhat unequal, the upper apparently a little smaller than the lower; gills rather large, sub-triangular, two on each side, anteriorly and posteriorly grown together; no special siphons are present.

The shells are mostly elongately, or broadly and ovately, sub-trigonal, with two or three cardinal hinge-teeth in one and three or four in the other valve, they are either smooth or, more generally, partially transversally sulcated; there are two muscular impressions, each, and especially the posterior, is superseded by a distinct small pit which is caused by the retractile muscles of the foot. In the *Trigoniæ* the posterior of these muscles appears to be the stronger one, while in the *ASTARTIDÆ* the anterior is the much stronger one. The pallial impression is always entire, the ligament external, and the internal structure either pearly or calcareous.

As regards the anatomy of the animals the *Trigoniæ* are intermediate between the *NUCULIDÆ* and the *ARCIDÆ*, clearly showing most marked relations to the former. The shells, on the other hand, exhibit a great similarity to those of the *ASTARTIDÆ* and *CRASSATELLIDÆ*, both in the general form as well as in the distribution of the hinge-teeth, though this relation is not so apparent in the recent as it is in the fossil forms, the former exhibiting in the striation of the hinge-teeth considerable affinities to the hinge of the *NUCULIDÆ*.

* The most recent and best account of the anatomy of a recent species, probably *T. margaritacea*, is published by Dr. E. Selenka in *Malacozool. Blätter*, xv, p. 68.

The genera which I shall refer to the present family are: *Curtonotus*, *Schizodus*, *Neoschizodus*, *Myophoria*, *Trigonia*, *Meekia* and *Remondia*. The first is based upon a Devonian and the second upon a Permian species, the third and fourth are triassic, the fifth is chiefly jurassic and cretaceous; in tertiary rocks already *Trigoniæ* are very rare, and only one type (the *Pectinatae*) extends into the present (Australian) seas; the two last named genera are proposed for peculiar cretaceous shells, which may already occur in the jurassics. This shows the geological development of the family. The older forms, like *Schizodus* and *Myophoria*, principally differ from *Trigonia* by the want of the grooves or striæ on the hinge-teeth, while *Remondia* and *Meekia* seem to indicate, by the larger number and distribution of the sulcated hinge-ribs, a strong relation to the *CRASSATELLIDÆ*. Further details will be found in the characteristics given of the different genera. With reference to the genus *Verticordia* (and the several forms identical with it), classed in the present family by H. and A. Adams, I have already observed, that its proper place appears to be in the *CHAMACEA* (*vide* p. 224). It is difficult to explain the peculiar assemblage of fossil genera, referred to this family by Chenu in his *Man. de Conch.* I should almost think it must be an accidental error, though Mr. Chenu's classification of fossil genera is by no means free from blunders.

1. *Curtonotus*, Salter, 1863, (? 1855), (*Quart. Journ. Geol. Soc., Lond., xix, p. 494*). Shell elongately ovate, moderately tumid, sub-equilateral or inequilateral, with the beaks almost anterior; hinge in the right valve with two diverging sub-marginal cardinal teeth separated by a large pit, the anterior tooth being stronger than the posterior; left valve with a large median and, on each side, one sub-obsolete marginal cardinal; muscular scars very elongated, pallial impression distant from the margin of the shell, which is smooth; type, *C. elongatus*, Salt. (*l. cit., p. 495, fig. 5*). Salter refers a few Devonian species to this genus. It seems very closely allied to King's *Schizodus*, but has not the broad median emarginated tooth in the left valve fitting into a special pit of the right valve; the forms of *Curtonotus* are also much more regularly oval.

2. *Schizodus*, King, 1844, (*Perm. foss. of England, &c., 1850, p. 185*). Shell obliquely ovate, posteriorly somewhat produced, moderately tumid in front, with the beaks close together, incurved and sub-terminal; hinge of right valve with two diverging sub-marginal cardinal teeth, of left valve with three cardinal teeth, one marginal on each side and a median largest, more or less distinctly bifid; surface smooth, or with fine concentric, and sometimes also with a few radiating, lines; type, *Sch. obscurus*, Sow. This species was described by Sowerby as *Axinus*, but the first species noted by the author under this last genus is a quite distinct tellinoid shell from the London clay, *Axinus angulatus*, and consequently the present genus cannot be identified with *Axinus*, as has been done by various writers. Species of *Schizodus* have been mostly described from the upper palæozoic rocks; lately there have also some triassic species been referred to it, (*Ann. des sc. géologiques, Hebert and M. Edwards, I, 1869, p. 136*), but it does not seem certain whether they belong to this or to the next genus; in fact the generic determination of these shells appears to me to be quite problematic.

3. *Neoschizodus*, Giebel, 1856. (Verst. des Muschelk. von Lieskau, p. 40, in Abhand. Nat. Verein, Halle). Shell similar to *Schizodus*, hinge of the left valve with a large posterior sub-terminal cardinal tooth, posteriorly prolonged, parallel to the fulcrum which are distinct from the margin itself, and with an anterior terminal cardinal; right valve with a marginal elongated posterior and a sub-terminal shorter but thicker anterior cardinal tooth; type, *N. lævigatus*, Giebel, from triassic beds near Lieskau (Germany). According to the characteristic taken from the figure of the type-, and another, species, Giebel's *Neoschizodus* must be considered as distinct from *Schizodus*, as well as from *Myophoria*, with which it has lately been identified by several authors, for unless the figures have been proved to be incorrect, these identifications cannot be accepted.

4. *Myophoria*, Bronn, 1835,* (*vide* Leth. geog., 2nd edit., II, p. 66; Richter in Zeitsch. deutsch. geol. Gesellsch., 1869, xxi, p. 444). Shell similar to *Schizodus*, smooth or concentrically striated, or partially radiately ribbed; hinge in the left valve with three diverging sub-equal cardinal teeth, the middle one being the thickest and sometimes bifid, while the outer ones are marginal; the right valve has two teeth, both of which are marginal, and the posterior sometimes striated or denticulated; the other teeth are rarely distinctly striated; muscular impressions close to the hinge-teeth, and generally margined on the internal side by a raised rib; type, *M. vulgaris*, Schloth. All the species as yet known are from triassic rocks, and chiefly from the upper series of that formation. The hinge-teeth greatly resemble in their arrangement those of *Schizodus*, while those of *Neoschizodus* appear to be closely allied to those of *Cardita*, as noted by Giebel.

5. *Trigonia*, Brug., 1789, (*Lyriodon* apud Bronn). Shell oblong, inequilateral, with the beaks sub-anterior, rounded in front, more or less produced and obliquely truncate posteriorly, pearly inside; ornamentation variable, with concentric or radiating or sometimes divaricating ribs; hinge with two diverging teeth in the right valve and three in the left, the median large, sub-trigonal, internally indented, the outer comparatively very small, thin, similar to those in *Schizodus* or *Myophoria*; the teeth of the right valve are transversally ribbed on both sides, those of the left only internally, where the right ones fit in; type, *T. margaritacea*, Lam. Fossil species occur from the Lias upwards.

Agassiz, in his "Mémoire sur les Trigones" (Etudes m. fossiles, I, 1840,) proposed to group the numerous, chiefly fossil, species into several sections, merely to facilitate the arrangement of the various forms. I shall briefly allude to them as such convenient sections. The transitions from one group to the other are so gradual and varied that no strictly classificatory value can be attached to these, at least hardly equivalent to what may be called sub-genera. There also appear to be too many sub-divisions; they could be with advantage reduced to five or six, and would thus admit of a better definition.

a. *Scaphoidea* (including *Clavellatae* and *Scabrae*). Shell scaphoid, truncate, or slightly convex in front, with sub-terminal and somewhat recurved beaks, posteriorly attenuating by a very easy curve, the upper edge being somewhat concave;

* The year 1829 is quoted by Bronn himself "in litteris."

area very large, transversally striated or finely costated, laterally well margined; sides of shell ornamented with strong transversally curved and more or less strongly tuberculated ribs, which in front become more or less irregular and sometimes partially obsolete. The best known species of this type is probably *T. scabra*, Lam. This group is equally represented in jurassic as in cretaceous strata.

b. Undulatæ. Shell moderately produced posteriorly, with a rapidly descending areal margin; area transversally striated, not distinctly margined laterally; sides ornamented with angularly bent ribs, the longer anterior portions of them being arranged concentrically, the posterior more or less obliquely descending or even quite vertical; the ribs are generally partially smooth, partially tuberculated; type, *Tr. sulcataria*, Lam. This group is represented in the jurassic and cretaceous strata. A peculiar form mostly partaking of the characters of this group is d'Orbigny's *Tr. Hanetiana* from the uppermost cretaceous beds of Chili. The ribs are in front almost vertical and towards the area scarcely angular.

c. Costatæ. Shell sub-trigonal, high, beaks sharp and prominent, posteriorly more or less sharply descending, area broad, margined laterally by a strong rib and usually ornamented with granulated decussating striæ of which the radiating ones predominate; sides ornamented with concentric smooth ribs; type, *Tr. costata*, Lam. The *Costatæ* are chiefly jurassic species, only few occur in cretaceous deposits.

d. Glabræ. Shell sub-quadrangularly or elongately ovate, moderately compressed; area laterally not margined, or only indicated by an indistinct groove; sides ornamented with smooth concentric ribs, sometimes extending on the areal region and at other times becoming quite obsolete before they reach it; type, *Tr. longa*, Ag. This group is very rare in the Jura, and most of the known species are cretaceous.

e. Quadratæ. Form sub-quadrangular, broadly truncate behind; area indistinctly margined; sides ornamented with irregular divaricating and bifurcating sub-obsolete ribs, frequently broken into numerous granules or tubercles; type, *Tr. dædalæa*, Park. The *Quadratæ* are scarce, but occur in both the jurassic and cretaceous deposits.

f. Pectinatæ. Shell broadly oval, sub-caudate posteriorly, area not distinct; the whole shell ornamented with radiating sub-tuberculated ribs; type, *Tr. margaritacea*, Lam.; this group is only found recent.

All the groups with the exception of the last are found represented in cretaceous deposits, as well as in the jurassics. Giebel mentions that the genus also occurs in Devonian rocks, but I have not seen any typical species from beds older than the Lias. Tertiary species are only very few.

Giebel described (Jahresb. Ver., Halle, 1852, v, p. 379, pl. v, fig. 2), a *Tr. septaria* from tertiary beds near Biere; it belongs to the *Scaphoidea* group, and somewhat resembles the South American *Tr. Hanetiana*, d'Orb., first noted from a tertiary deposit, but subsequently transferred by the same author into the Senonien.

6. *Remondia*, Gabb, 1869, (Pal. Calif., II, p. 270). Shell compressed, elongately sub-quadrate, inequilateral, the beaks being sub-anterior; ligament very short, external; hinge composed of three moderately diverging, elongated cardinal teeth and one long posterior lateral in the left valve; those of the right would appear to be similar and corresponding to those of the left. "The middle cardinal of the left valve is transversally striated, as in *Trigonia*, and is slightly grooved on its face; the anterior is linear and smooth, and the posterior is also smooth, at least on its posterior face. The posterior lateral and its corresponding cavity are irregularly rugose. In the right valve the anterior tooth is as large as the middle, the posterior is linear;" type, *R. furcata*, G., from cretaceous beds of Mexico.

The only other species which I believe to belong to this genus is the peculiar *Astarte Bronnii*, described by Prof. Krauss from the upper series of some fossiliferous beds near the Algoa Bay (South Africa), which beds he at the time (1839) considered to be equivalent to the "Lower Greensand." Very likely Krauss was correct in his first identification, though others have subsequently pronounced the same beds to be of jurassic age. Krauss (Nov. Act. Acad. Cæs. Leop., xiv, pt. ii, 1850, p. 449, pl. xlviii, fig. 1), already mentioned that *A. Bronnii* probably belongs to a new genus. Its hinge closely corresponds with that of *Remondia*. Each valve has three elongated cardinal teeth, the median ones being the strongest, and there also appears to be one very long, sub-marginal tooth in each valve present. The median tooth of the right valve is transversally striated on both sides, in the left only on the anterior side, and here the first tooth is also striated on the posterior side, opposite the former. The shell is also of a form similar to the type species of *Remondia*, elongated, with the beaks almost anterior, but somewhat more tumid and posteriorly more attenuated. The valves seem to have been in the present species gaping posteriorly, on which point Gabb was too uncertain to give a decided opinion.

It is not improbable that some other fossil species of *Astarte* and *Crassatella* will be shown to belong to the present genus, as, for instance, *Cr. Bandeti*, Coq., Pal. Prov. Const., pl. xiii, fig. 5.

7. *Meekia*, Gabb, 1864, (Pal. Calif., I, p. 191). Shell oblong, sub-inequilateral, posteriorly rounded, anteriorly somewhat produced and turned upwards hook-like, terminating in a point; surface marked with striæ of growth only; hinge with "two robust, triangular teeth on the right valve, and one large and one small one on the opposite side, the large one being received between the two of the right valve; posteriorly on each side is an indistinct lateral tooth." "A short robust plate separates the anterior muscular scar from the cavity of the beak." Type, *M. sella*, G., and two others are the only known species of the genus; they are from cretaceous deposits.

It is, as Gabb remarks, uncertain where to class this peculiar genus, but the general character of the shell and of the hinge-teeth appears to me to have a greater similarity to the hinge of *Schizodus* and *Neoschizodus*, than to that of any other known genus.

LIST OF CRETACEOUS SPECIES.

As there are in this case no suggestions to be made regarding newer generic determinations, I shall simply quote the names of the cretaceous species of *Trigonia* according to Pictet and Campiche (Pal. Suisse IV^{me} ser., 3^{me} partie, p. 384), and add those which are not included in the list of those authors. With the exception of the *scabræ* and *clavellatæ* groups which I have united with the *scaphoidea*, the groups remain the same, as noted by Pictet and Campiche.

1-18.—*T. longa*, Ag., *Sanctæ-crucis*, P. and C., *carinata*, Ag., *peninsularis*, Coq., *angulifera*, Stol., (*abrupta** of Coquand), *scapha*, Ag., *Robinaldina*, d'Orb., *cincta*, Ag., *dædalea*, Park., *nodosa*, Sow., *Iusitanica*, Sharpe, *decora*, Stol., (*Hondaana*† of Coquand), *ornata*, d'Orb., *divaricata*, d'Orb., *caudata*, Ag., *Picteti*, Coq., *Lamarckii*, Math., *paradoxa*, Ag.

19-23.—*T. Heva*, Dolf., *aliformis*, Park., *Archiaciana*, d'Orb., *Fittoni*, Desh., *Constantii*, d'Orb.

24-47.—*T. Coquandiana*, d'Orb., *sinuata*, Park., *excentrica*, Sow., *sub-excentrica*, d'Orb., *neglecta*, Guér.,† *pennata*, Sow., *sulcataria*, Lam., ? *Nereis*, d'Orb., *disparilis*, d'Orb., *Buchii*, Gein., *echinata*, d'Orb., *sub-pulchella*, d'Orb., *spectabilis*, Sow., *Delongchampsii*, M.-Chal., ? *bipartita*, d'Orb., *crenatula*, Lam., *spinosa*, Park., *Pyrrha*, d'Orb., *scabra*, Lam., *limbata*, d'Orb., *longirostris*, d'Orb., *tenuisulcata*, Duj., *inornata*, d'Orb., *pumila*, Nilss.

48-49.—*Trig. Elisæ* and *Ludovicæ* are described by Briart and Cornet from Belgium, (Foss. de Bracquegnies, p. 64, Mém. cour. Acad. Belgique, vol. xxxiv.

50-52.—*T. intermedia*, Fahrk., *Jonioi*, Rouill., and *Falckii*, Rouill., are described by Eichwald from cretaceous beds of Russia (Leth. geogn., livr. x, 1867, p. 601 et seq.). Besides these the same author mentions *T. nodosa*, *carinata*, *scabra*, *inornata*, and *caudata*.

53-54.—*T. distans* and *Auressensis* are described by Coquand from North Africa (Pal. Prov. Const., pp. 202-203).

55-57.—*Tr. Herzogii*, Hausm., *concardiiformis*, Krauss, and *ventricosa*, Kr., are noted by Krauss from the neighbourhood of Algoa Bay from supposed cretaceous rocks, (Mem. Leop. Acad., xiv, pt. ii, p. 453 et seq.), and from the same locality is the next species

58.—*Remondia Bronnii*, Kr. (ibid. p. 449).

59-66.—*T. Delafossei*, Coq. and B., *Hanetiana*, d'Orb., *Gibboniana*, Lea, (= *Hondaana*, Lea, Pal. Calif., ii, p. 248), *Tocaimana*, Lea, ? *Lojoyei*, d'Orb., (= ? *longa*, d'Orb., ex parte Prod. ii, p. 78, No. 289), *sub-crenatula*, d'Orb., *abrupta* and *Humboldtii* of Buch are from South America.

67-75.—*T. plicato-costata*, Gal., *Mooreana*, Gabb., (Pal. Calif., ii, p. 269), *thoracica*, Mort., *Emoryi*, Con., *texana*, Con., *Eufalensis*, Gabb., *Evansiana*, Meek, (vide Smith. Misc. Coll., No. 177, 1864, p. 9, where also *T. limbata*, d'Orb., ? is mentioned); further, *T. Tryoniana*, Gabb., and *T. æquicostata*, Gabb., (Pal. Calif., i, p. 188, and ii, p. 196 and p. 248), are described from N. America (including Texas and Mexico).

76-78.—*Meekia sella*, *radiata* and *navis*, Gabb., (Pal. Calif., i, pp. 179-180), are from California.

79.—*Remondia furcata*, Gabb., (ibid. p. 270) from Mexico.

From Palæstine Conrad described in the App. to the Off. Rep. of Lynch's Expedition several species which he considers as jurassic, but Fraas (Würt. Nat. Jahreshfte, xxiii, 1867, pp. 237-238) questions the fact. Conrad's *syriaca* he considers as identical with *sinuata*, Park.; the others are *alta* and *cuneiformis*, based upon imperfect cast specimens; the latter has great similarity to

* I agree with Pictet that the identification with the American species is doubtful. There are, indeed, most marked differences in the thickness of the shell, direction of the ribs on the sides and on the area, and in the size of the ligamental fulera as compared with *T. gibboniana*, and in *abrupta* the differences in the form and ornamentation of the shell are still more apparent.

† Vide Album Pal. d. l. Sarthe, &c. 1867, pl. xix, fig. 1. On this and the previous plate several other species of *Trigonia* are figured.

caudata, Ag. Fraas also describes and figures (l. cit., p. 237, pl. iv, fig. 17), a "*T. distans*, Conr.," but does not say whether the species is the same as Coquand's *distans* from Algier. The figures of both show a great similarity, but in the Palæstine form the median areal rib appears to be absent.

80-85.—The following species occur in Southern India: *T. scabra*, Lam., *tuberculifera*, *indica*, *orientalis*, *semiculta*, *minuta*, and *crenifera*.

TRIGONIA, Brug., 1789, (see p. 310).

a. Group,—*Scaphoidea*.

1. TRIGONIA SCABRA, Lam., Pl. XV, Figs. 24-26, and Pl. XVI, Figs. 35-40.

1819. *Trigonia scabra*, Lam., An. sans vert., vol. vi, p. 63.
 1846. „ *aliformis*, Park. apud Forbes, Trans. Geol. Soc., Lond., vii, p. 151, non *idem*, Park.
 1850. „ *limbata*, d'Orb., Prod. II, p. 240, ex parte, *idem* Gabb, Zittel, et auctorum.
 1865. „ *scabra*, Lam., apud Zittel, Denk. Akad., Wien, xxiv, pt. ii, p. 161, cum syn.

Trig. testa elongatim sub-trigona, valde inæquilaterali, moderate inflata, umbo-nibus postice versus paulo incurvis, sub-anterioribus, postice producta, attenuata et ad terminationem anguste et oblique sub-truncata, antice rotundata, margine inferiori fere uniforme curvato, marg. areali subrecto aut paululum concavo, costis 16-24 concentricis paulo curvatis, tuberculis acutis coronatis, antice sub-obsoletis, ornata; area transversaliter costulis numerosis sub-spinulis, terminalibus cum costis lateralibus nonnunquam angulum acutum formantibus, nonnunquam sub-obsoletis notata, sulco longitudinali, haud profundo, sub-mediano divisa.

The ornamentation of the surface is subject to great variation. When the shell is well preserved the ribs are provided with very distinct spinulose tubercles and separated by deep interspaces which are broader than the ribs themselves; in young specimens this is particularly apparent. When, however, the surface of the valves becomes worn off the tubercles often quite disappear, the ribs are then smooth and apparently broader than the interspaces. All these variations are amply illustrated in the figures cited above.

Our South Indian form had first been identified by Forbes with Parkinson's *aliformis*, but Forbes never saw a perfect specimen of the Indian form, and the anterior parts of both the species are very easily mistaken, the one for that of the other. D'Orbigny, apparently acting more on geological than on conchological evidence, considered the Indian form identical with his *limbata*, and this statement has been accepted as correct by subsequent writers. Zittel refers to it as if there were not the least doubt about it. But an examination of a large series of the Indian fossils proved them to belong to *scabra* of Lamarck, as distinguished from *limbata* by more straight, more numerous and equally tuberculated ribs and less concave areal margin. Both species are, however, very closely allied, and it is often far from an easy task to separate one from the other.

Localities.—Near Anapaudy, Koloture, Serdamungalum, Coonum and Shutamungalum; North of Karapaudy.

Formations.—Trichinopoly and Arrialore groups.

The last named locality refers to the latter group, and the specimens from it generally have the ribs thin, and very distinctly tuberculated; they are also probably slightly less inflated than those from the other group, but there is no important specific distinction between both.

In Europe *T. scabra* is common through all the upper cretaceous beds of Germany, France, and the Alpine Gosau deposits.

2. TRIGONIA TUBERCULIFERA, *Stoliczka*, Pl. XV, Figs. 10-12.

Trig. testa late ovata, fere æqualiter longa quam alta, valde inæquilaterali, tumida, umbonibus sub-anterioribus, prominentibus, incurvis instructa, antice leviter convexa, infra valde rotundata, postice breviter producta et valde angustata, margine areali moderate concavo; superficie costis 16-18 crassis æquidistantibus, paulo undulatis, aut sub-rectis, tuberculis obtusis coronatis, postice multo tenuioribus, interdum sub-lævigatis, ornata; area moderate profunda, sub-angustata, fere lævigata.

This species bears a remarkably close resemblance to the South African *T. ventricosa*, described by Krauss (*Acta nov. Acad. Leop. Car.*, xiv, pt. ii, p. 456, pl. 49, fig. 2,) from supposed cretaceous beds which have subsequently been referred to the jurassic period.* I have given (on pl. xv, fig. 9), for the sake of comparison, two views of the African shell, as Krauss's illustrations are not sufficient. Our Indian species differs from this only by being of a more regularly rounded triangular shape, less attenuated and produced posteriorly, and possessing a narrower and not so deeply excavated area. The only other shell closely allied, if not identical with the African fossil, is one found by Mr. Wynne in the jurassic beds of Cutch. I shall have occasion to allude to this at some future date in connection with the examination of the Cutch fossils.

Locality.—Coonum, in a greyish sandstone.

Formation.—Trichinopoly group.

b. Group,—*Costatæ*.

3. TRIGONIA INDICA, *Stoliczka*, Pl. XV, Figs. 14-15.

T. testa sub-trigonalis, valde inæquilaterali, sub-tumida, antice rotundata, infra margine convexo, postice gradatim attenuata, moderate producta et ad terminationem oblique truncata, costis 12-13 concentricis, lævigatis, crassis, antice ad marginem sub-recte terminantibus, sulcis paulo latioribus separatis, ornata; area lata, ad medium angulata, intus aut planulata aut paulo excavata, striis transversalibus

* I have no doubt that the secondary deposits of South Africa are in part with propriety referred to the jurassic period, but I am not sure whether they all belong to that formation. Besides the *Trigonia ventricosa* there is a *Remondia*, a *Grotriania*, and a *Ptychomya*, and several other shells which have a cretaceous more than a jurassic aspect. It yet remains to be shown whether Krauss was not correct in his identification of some of the beds with cretaceous deposits, equivalent to the Lower Greensand of Europe.

notata, extra in facie laterali lævigata et costa elevata ab apice ad marginem infero-posteriorem decurrente marginata.

The anterior straight or slightly flexuous termination of the ribs and the large prolonged area readily distinguish this species from others; it belongs to a group chiefly jurassic, and only rarely represented in cretaceous deposits. It seems to be a very rare species.

Locality.—South-east of Arrialoore, in a whitish silicious sandstone.

Formation.—Arrialoore group.

c. Group,—*Glabræ*.

4. TRIGONIA ORIENTALIS, Forbes, Pl. XV, Figs. 16-17.

1846. *Trigonia orientalis et suborbicularis*, Forbes, Trans. Geol. Soc., Lond., vii, p. 150, pl. xviii, figs. 11 and 10.

1847. „ *semiornata*, d'Orb., Voy. Astrol., Paléont., pl. iv, figs. 31-32.

1850. „ *orientalis et suborbicularis*, Forbes, apud d'Orbigny, Prod. II, p. 240 ;—*eædem* auctorum.

T. testa quadrangulariter sub-trigonata, moderate tumida, inæquilaterali, antice breviori, late et uniforme convexa, postice moderate producta, regione ab umbone ad marginem infero-posteriorem extensa obtuse angulata, area supera ab eo angulo rapide declivi, ad terminationem oblique sed late truncata, et sulco mediano indistincto divisa, parte areali interiori concentricè multistriata, exteriori precipue prope marginem posteriorem lævigata; superficie cetera costis numerosis concentricis, lævibus, æquidistantibus, antice ad marginem fere obsoletis induta.

The young shells generally are much flatter and always more distinctly sub-quadrangular than old ones; in the latter the posterior part of the shell becomes more produced, while the anterior does not increase at the same ratio. The concentric ribs are numerous, smooth, very gradually increasing in thickness as the shell grows, becoming at the same time more or less distant from each other; near the periphery the furrows equal in width the thickness of the ribs; they terminate anteriorly with a very slight flexuosity, but become nearly quite obsolete before they reach the margin. The area is very broad, separated from the costated portion of the valves by an obtuse angle, not quite so indistinct as in the typical forms of the “*Glabræ*” group, but at the same time not developed to a distinct rib, as in the “*Costatæ*.” This area is divided by a very shallow sulcus in two sub-equal halves: on the interior portion the concentric striæ are distinct in all stages of growth, but on the outer portion they become more or less obsolete, especially towards the margin.

I have compared both of Forbes' originals; they are not so perfect as shown in his figures, but except that in the one the ribs are slightly more distant than in the other, I do not see any essential difference between both.

Locality.—Comarapolliam and near Pondicherry, in a light grey and bluish sandstone.

Formation.—Arrialoore group.

5. TRIGONIA SEMICULTA, Forbes, Pl. XV, Figs. 19, 22, 23, 27.

1846. *Trigonia semiculta*, Forbes, Trans. Geol. Soc., Lond., vii, p. 151, pl. xviii, fig. 9.
 1847. „ *sinuata*, Park., apud d'Orb., Voy. Astrol., Paléont., pl. iv, figs. 29-30—non eadem Parkinson.
 1850. „ *semiculta*, Forbes, apud d'Orb., Prod. II, p. 240;—eadem auctorum.

T. testa elongate sub-quadrangulati, inæquilaterali, moderate compressa, verticibus obtusis parvulis instructa, antice et infra rotundata, postice producta, ad terminationem late truncata, area paulo convexiuscula, latissima, elongate trigonali, lævigata, in junioribus speciminibus supra longitudinaliter sub-sulcata atque pone vertices transversaliter costulata; superficie cetera concentrice multicostata, costis lævigatis, obtusis, fere æquidistantibus, antice paulo deflexis et usque ad marginem continuis.

This species is readily recognised from the previous by the anterior termination of the concentric ribs, which are bent somewhat downwards and extend up to the extreme margin. It is a more compressed and posteriorly more produced shell than *T. orientalis*; young specimens are, however, very closely allied, and the anterior termination of the ribs becomes the sole distinguishing character.

This is no doubt the species which d'Orbigny first identified with the European *T. sinuata* of Parkinson, and both are indeed very closely allied to each other, the only difference being that the Indian shell has a somewhat wider, smooth area, and that it is posteriorly truncated, instead of being gradually narrower and terminally rounded, as seen in the various figures of *sinuata*. I have no specimens of this last to compare, but should that character prove not to be constant, I would without much hesitation consider both shells as belonging to the same species. D'Orbigny's figure in the Voy. d'Astrolabe appears to be an enlarged one of a young specimen, but I was unable to trace out the original in the 'Jardin des plantes' collection. In the Prodrôme, (II, p. 240,) d'Orbigny wrongly identifies *sinuata* from Pondicherry with *suborbicularis*, Forbes, retaining the last one as distinct from *orientalis*, Forb. This is a double mistake, as already pointed out.

Another species allied to *semiculta* was described by Conrad as *T. syriaca* from Palæstine. Fraas pronounces it to be the same as *T. sinuata*, Park.

Locality.—Neighbourhood of Anapady and north-east of Maithal, in a compact calcareous, and in soft, sandstone; rare.

Formations.—Trichinopoly group.

6. TRIGONIA MINUTA, Stoliczka, Pl. XV, Figs. 18, 20, 21.

T. testa parva, elongato sub-trigonata, valde inæquilaterali, regione ab apice ad marginem postero-inferiorem decurrente obtuse angulata, postice producta, attenuata et ad terminationem angustatim truncata; margine lunulari et areali fere rectis, angulum 105° ad apices formantibus; lunula angusta, elongata paululum excavata, area perlonga, angusta, fere plana, ambabus lævigatis; superficie costulis

12-16, *lamelliformibus, acutis, distantibus, in declivitate postica continuis, interspatiis latis, haud profundis, minutissime striatis, notata.*

This interesting small form may be regarded as a miniature of the European *T. excentrica*, Park. The ribs on the surface are peculiar, sharp, but little prominent, and with very shallow, broad, minutely striated interspaces. The lunula and area are both distinctly margined, narrow, and smooth, the first somewhat excavated, the second almost quite flat. It is very rare that a distinct lunula is present in any of the species of *Trigonia*, only the "*Glabræ*" have it occasionally indicated, though I do not know a single species which has it equally marked as this small Indian shell. It might, therefore, be suggested that the species could rather belong to *Astarte* than to *Trigonia*; but against this the examination of the hinge-teeth of the right valve speaks, there being in it only two diverging and distinctly striated cardinal teeth present under the beak.

Locality.—Near Arriallor, in a soft whitish sandstone.

Formation.—Arriallor group.

d. Group,—*Quadratae*.

7. *TRIGONIA CRENIFERA*, *Stoliczka*, Pl. XV, Fig. 13.

T. testa sub-quadrangulari, paulo inflata, inæquilaterali, antice breviter rotundata, postice producta et ad terminationem late ac subrotunde truncata, superficie costulis tenuibus paulo flexuosis omnino confertim crenulatis ornata, iis in area perlata cum adjacentibus in regione ab apice ad marginem infero-posteriorem extensa positis angulos fere rectos formantibus.

A very marked species, easily recognised by the numerous finely crenulated ribs being present on the entire shell. The form is a little longer than most other species of the "*Quadratae*" group, but the ornamentation is typical.

Locality.—Olapaudy, in a brownish somewhat oolitic rock; apparently very rare.

Formation.—Arriallor group.

XXXIV. *Family*,—*NUCULANIDÆ*.

(*LEDIDÆ*, auctorum).

The animals have the mantle margins almost entirely open, except posteriorly for a very short distance, a narrow commissure separating a posterior siphonal opening, through which partially, or almost wholly, united, retractile, siphons can be protruded; the exhalent siphon is occasionally represented by a simple mantle fold; sometimes, as in *Nuculana* and *Neilo*, special appendages of the mantle occur below the siphons; these apparently assist in hatching the young, and I doubt whether they are constant in the different species. There is one pair of palpi on either side, they being elongated and pointed; one pair of unequal

elongated and narrow gills on each side, only free along the inferior edge; the foot is rather short, terminally expansible into a sub-oval disc, truncate or slightly emarginated behind, pointed in front, with serrated edges, deeply sulcated along the middle sole, and capable of being folded together when retracted within the valves.

The shells are elongated, small, or of moderate size, posteriorly always more or less produced and often slightly gaping; the hinge is composed of two comb-like multidenticated diverging marginal teeth; ligament internal or external; pallial impression generally sinuated, rarely nearly entire; internal layer of shell sometimes slightly nacreous, but more often only with a slight silky lustre.

The *NUCULANIDÆ* are characterized, as already stated, principally by the distinctly developed posterior siphons and the frequently sinuated pallial sinus, the shells are produced posteriorly, while the reverse is the case in *Nucula*. There is really a very great structural difference between *Nuculana* and *Nucula*, and Deshayes' criticism of H. and A. Adams' and other authors' classification is entirely uncalled for. It contributes nothing towards Deshayes' suggested unity, but it speaks rather in favor of the separation of the two families. No one will deny the relations of the two as to animals and shells, they are only too well known, but when the differences of organisation extend to such characters as those upon which our whole systematic classification is based, it would be the greatest mistake to ignore them in one and make use of them in another case.

Fossil species of *NUCULANIDÆ* occur through all the known sedimentary formations, but they never are very numerous, and appear to increase very gradually up to the present date. The palæozoic species will barely amount to 15 or 20, those from the Trias about 25, from the jurassic period about 40, from the cretaceous 63, from the tertiary at least 80, and from the present seas nearly 100.

The geographical distribution is general; the species of *Nuculana* live mostly in tropical and sub-tropical, those of *Yoldia* chiefly in the Northern, seas. The usual depth at which they occur is between 2 and 4 fathoms, on slightly gravelly, sandy, or muddy soil. During former geological periods the same general distribution appears to be indicated, at least species belonging to the family have been found almost in all countries and are about equally scarce.

According to the more or less distinct internal pearly structure and the presence of an internal ligament on the one hand, the want of the former and the replacement of the latter by an external ligament on the other, two sub-families have been proposed by H. and A. Adams under the respective appellations of *NUCULANINÆ* and *MALLETINÆ*. These I shall here adopt, classifying the few additional fossil genera according to their relations to recent forms.

a. *Sub-family*,—*NUCULANINÆ*.

1. *Cucullella*, M^cCoy, 1851, (Ann. Mag. Nat. Hist., 2nd ser., vii, p. 50). Shell sub-rhomboidal or elongated, inequilateral, the beaks being sub-anterior, internally with a long internal septum extending towards the anterior muscular

impression; hinge-line crenulated or denticulated in the whole extent, pallial line entire (?); type, *C. cultrata*, Sandberger, (Rhein. Schichtensystem, &c., p. 276, pl. 29, figs. 3 and 7). This is one of the oldest forms of *NUCULANINÆ*, differing from *Nuculana* (= *Leda*) by the internal rib-like septum below the beaks. The form of the shell varies from elongated to almost quadrangularly ovate. McCoy says that the pallial line is entire; it may be so, but it is not clearly traceable in any of the figures I saw. All the species of *Cucullella* are from palæozoic rocks.

2. *Perrisonota*, Con., 1869, (Am. Journ. Conch., V, p. 98). Shell "elongated, posterior hinge-line long, curved, linear, with numerous close transverse teeth, extending nearly to the end margin; anterior hinge area broad, oblique, and somewhat distant from the hinge margin; no fosset under the apex?" type, *P. protexta*, Con., from cretaceous rocks of New Jersey. It would seem from the above description that the anterior part of the hinge-line is destitute of teeth, but if that should not be the case, the mere form could hardly be considered as a sufficiently distinct character from the next genus, at least from its sub-genus *Adrana*.

3. *Nuculana*, Link, 1807, (= *Leda*,* Schuhm., 1817). Shell with the valves closed, inequilateral, posteriorly produced and attenuated, surface finely concentrically striated and covered with a smoothish epidermis; hinge-line divided into a great number of teeth, cartilage in a small pit below the beaks, which are very close to each other; pallial line slightly sinuated; internal nacre of shell more or less distinct; type, *N. emarginata*.

3 a. *Adrana*, H. and A. Adams, 1857. Shell greatly elongated and thin, with the valves somewhat gaping at both ends; type, *Nuc. [Adrana] lanceolata*, Lam.

4. *Yoldia*, Möller, 1832. Shell elongated, narrowed behind, or obliquely truncated, thin, covered with a polished olivaceous epidermis, slightly pearly within; cartilage in a large pit below the beaks; hinge-teeth comb-like; pallial sinus large; type, *Y. lanceolata*, Sow. Among fossils it would seem extremely difficult to distinguish between *Yoldia* and *Nuculana*, unless the relative size of the cartilage pit and of the pallial sinus can be a guide. The animals of the former are said to have no posterior appendages at the mantle below the siphons, so conspicuous in *Nuculana*. It remains yet to be shown whether all the species of the last genus really possess the same.

4 a. Chenu adds as a sub-genus of *Yoldia* Mörch's *Portlandia*, quoting (evidently by mistake) two fossil species, *Y. Hæsendonkii*, Nyst, and *Y. pectinata*, Sow.; the former a tertiary, the latter a cretaceous shell. The first is concentrically sulcated, the second radiately ribbed or striated; both have the lunula somewhat excavated, but they do not appear to me to differ from true *Nuculæ*. Hanley (Monog. *NUCULIDÆ*) says that *Portlandia* differs from *Yoldia* merely by having the valves posteriorly closed. He quotes in the section a number of small somewhat tumid species, like *Y. pygmæa*, Münster.

* This name has also been given to an Arachnoid by Koch.

b. *Sub-family*,—*MALLETINÆ*.

5. *Nucularia*, Conrad, 186? I have not met with the original description of the genus, but Conrad refers it to the *NUCULANIDÆ*. In his description of a cretaceous species from New Jersey (Am. Jour. Conch., V, p. 44,) he states that the shell is "not pearly, thin" "teeth angular, and tooth of the posterior line complicated;" the form is ovately elongated and inequilateral, the surface smooth, beak pointed, sub-anterior; one of the typical species appears to be the cretaceous *N. papyria*, Con., from Haddonfield (Am. Jour. Conch., V, pl. i, fig. 7, and p. 98, pl. ix, fig. 25, (lower figure in right corner).

6. *Malletia*, Desm., 1832. Shell elongately ovate, compressed, sub-inequilateral, smooth, covered with an olivaceous epidermis, interior sub-nacreous; hinge-teeth thin, denticulated, the anterior much less so than the posterior; ligament external, elongated; pallial sinus deep; type, *M. Chilensis*, Desm., (*Solenella Norrisii*, Sow.). Hanley describes a second species in his Mon. of *NUCULIDÆ*, *M. Cumingii*, from the Falkland Islands.

7. *Neilo*, H. and A. Adams, 1857. Shell sub-quadrangularly ovate, inequilateral, with the upper posterior margin arcuated, posteriorly sub-truncate, covered with a brown epidermis, anteriorly slightly gaping, inside not nacreous; hinge-teeth on both sides of the beak denticulated almost with interruption; pallial sinus deep; ligament external, small; type, *N. australis*, Q. and Gaim. (*N. Cumingii*, apud H. and A. Adams).

CRETACEOUS SPECIES OF THE *NUCULANIDÆ*.

All the recent genera and sub-genera appear to be represented in cretaceous rocks, but the distinction between *Nuculana* and *Yoldia* can as yet hardly be recorded with great accuracy. The *Nuculanae* usually are small, moderately tumid, rather strongly attenuated posteriorly and flexuously produced; the *Portlandia* are also of small size, tumid, and narrowly, but shortly attenuated, and the *Yoldia* are of larger size, very gradually attenuated posteriorly, not much produced and slightly flexuous. But unless the examination of the internal structure confirms the determination made according to these external characters, it cannot be looked upon as absolutely correct. A great difficulty exists in tracing out the pallial impression in fossil *Nuculanae*. Whether and which of the European species could be referred to *Perrisonota* and *Nucularia* of Conrad is at present difficult to say, because the genera are not yet sufficiently known as regards the type species themselves.

For reference of a large number of the species here recorded, see Pictet and Campiche, Pal. Suisse, III^{me} ser., 3^{me} part., p. 400 et seq.

1-2.—*Nuculana Valangiensis*, P. and C., *N. scapha*, d'Orb.

3.—*N. scaphoides*, P. and C. This extremely resembles, in form and size, the Californian type of cretaceous shells, called by Gabb *Meekia* (see family *TRIGONIDÆ*), but as the hinge of the only specimen of *scaphoides* does not appear to have been exposed, it is impossible to ascertain the generic determination of the species.

4-5.—*N. lingulata* and *solea* of d'Orbigny belong to the sub-genus *Adrana*.

6-11.—*N. Mariae*, d'Orb., *phaseolina*, Mich., *Neckeriana*, P. and Roux, *Vibrayeana*, d'Orb., *angulata*, Sow., *lineata*, Sow., (Trans. Geol. Soc., Lon., iv, pl. xvii, fig. 9, and Mém. Cour. Acad. Belg., Fossiles de Bracquegnies par Briart et Cornet, p. 63). The two last species recall the form of *Portlandia*, but they are noted as possessing the pallial sinus entire.

12-13.—*N. porrecta*, Rss., and *siliqua*,* Goldf., are both narrow, posteriorly much produced, resembling *Adrana* in type. Conrad's *Perrisonota* is a similar shell.

14-22.—*N. tellinella*, Rss., *semilunaris*, Buch, *producta*, Nilss., (Favre, M. foss. de Lemberg, 1869, p. 118†), *Mantelli*, Gein., *subæqualis*, Rss., *Puschii*, Alth, (*vide* Favre, M. foss. de Lemberg, 1869, p. 119), *Færsteri*, Müll., *Ehrlichi* and *discors*, Gümbel. The last species closely resembles *semilunaris*, Buch.

23-26.—*N. angusta*, Ryckh., *acutissima*, Müller, (? *caudata*,‡ Koch and D., in Petref. Aach. Kreidef., 1847, p. 16, and Supplement to the same, 1859, p. 28), *alata* and *Hagenovi*, Müller, (*ibidem*, Suppl.). All these are noted in Bosquet's list of Limbourg fossils in Staring's Bodem v. Nederland, II deel, Nos. 349, 350 (= 404), 351 and 352.

27.—*N. undulata*, Sow., (*Nucula ead.*, Sow., M. Conch., vi, p. 103, pl. 554, fig. 3, and *Leda ead.*, d'Orb., Prod. II, 136, No. 224). Pictet and Campiche place this species among the doubtful forms, considering it to be a *Neæra*. I have not examined any specimens, nor do Pictet and Campiche state whether they have done so. Their suggestion seems to be based upon Sowerby's remark, that the species may be a *Corbula*. As the shell is equivalve, it evidently does not belong to that genus, but it seems not improbable that it is a *Neæra*, though sufficient evidence appears as yet wanting.

28.—*N. tenuirostris*, Rss., (*Leda ead.*, apud d'Orbigny). Pictet and Campiche quote this species as probably identical with the supposed *N. undulata*, just mentioned. They evidently based their judgment only upon a superficial glance at the figures, for in Reuss' description the hinge-teeth are clearly pointed out (Böhm. Kreidef., pt. II, p. 7).

29.—*N. falcata*, Rss., (*ibidem*, p. 8,) must be for the present kept distinct from *semilunaris*, with which Geinitz suggested it might be identical. Judging from figures, there are marked differences in the shape of the two shells.

30.—*N. lyncuris* (*Leda lyncuris*, Eichwald, Leth. geog., xme livr., 1867, p. 594); this rather appears to be a *Nucula* than a *Nuculana*.

31-41.—*Yoldia Evansi*, Meek and Hayd., *scitula*, M. and H., *subnasuta*, Hall and M., *ventricosa*,§ H. and M.; *Nuculana bisulcata*, M. and H., *longifrons*, Con., *pinnæformis*, Gabb, *protexta*, G., *Slackiana*, G., *subangulata*, G., and *Neilo Hindi*, M., are noticed by Meek from the cretaceous deposits of North America in Smiths. Misc. Coll., No. 177, 1864, pp. 7 and 8.

42-54.—*Nuculana cultelliformis*, Rog., *Gabbii*, Con., *improcera*, Con., *oregona*, Shum., *penita*, Con., *parva*,|| Rog., *Willametensis*, Shum., *Neilo ? abrupta*, Con., *Yoldia acutifrons*, Con., *impressa*, Con., *nasuta*, Gabb, and *protexta*, Con., are marked from the so-called lower eocene beds of N. America by Conrad in Smiths. Misc. Coll., No. 200, 1866, pp. 3 and 4.

55.—*Nuculana translucida*, Gabb, Pal. Calif., I, p. 200.

N. perdita and *crebrilineata* of Conrad from Palæstine are identified by Fraas with *Nuculana scapha* and *subrecurva* of d'Orbigny respectively (*vide* Würt. Naturw. Jahresh., vol. xxiii, 1867, p. 236).

56-57.—*Nucularia papyria* and *Perrisonota protexta* are described by Conrad from New Jersey, (Am. Jour. Conch., V, pp. 44 and 93).

58-62.—*Nuculana socialis*, *Nuculana sp. ind.*, *Yoldia striatula*, *Y. obtusata*, and *Y. scaphuloidea* occur in the South Indian cretaceous deposits.

* Non *N. siliqua*, Reeve, (1856) = *Yoldia glacialis*, Gray.

† Favre's figure represents a rather more elongated form than Nilsson's original, or the figures given by Reuss in his Böhm. Kreidef., pt. ii, pl. xxxiv, figs. 17-20.

‡ Non *N. caudata*, Donovan, a recent species.

§ Non *N. ventricosa*, Hinds, 1843, a recent species of *Nuculana*. Pictet and Campiche consider Meek and Hayden's species to be a *Neæra*. Meek in his Check-list does quote a *Neæra ventricosa*, M. and H.; is this the same species or not?

|| Non *N. parva*, Sow. = *Nuculana minuta*, Müller, from the northern seas.

NUCULANA, *Link*, 1807, (see p. 320).1. NUCULANA SOCIALIS, *Stoliczka*, Pl. XVII, Fig. 13.

N. testa juniore trigonula, adulta ovatim elongata, minuta, solida, inæquilaterali, postice longiore, producta, sensim angusta, sub-recta, et ad terminationem truncatula, area angustissima, superficie polita, prope apicem fere lævigata, margines versus crassiuscule concentricè striata; cardine multidenticulato, denticulis foveola minima infra apicem sita interruptis.

Height of shell	:	its length	...	...	...	...	0.59
Thickness	„	:	„	...	...	...	0.45

This little species bears a remarkably close resemblance to some of our eastern forms, like *puellata*, *ventricosa*, and an apparently new species from Cochin and Aden. I dredged all three on sandy mud between two and three fathoms of water at the last locality. The peculiarity of the fossil species lies in its posteriorly almost perfectly straight and cuneiform produced shell. The surface is polished, nearly quite smooth at the beaks, and rather coarsely concentrically striated towards the margins.

Locality.—Moraviatoor, in a dark brown, calcareous and earthy rock; very common, the specimens having been evidently living in large numbers together.

Formation.—Ootatoor group.

2. NUCULANA, *sp. ind.*, Pl. XVII, Fig. 14.

A single cast specimen was found in the brown earthy limestone north of Odium; it belongs to a *Nuculana* or a *Yoldia*. Its broadly oval, sub-equilateral shape, and very numerous denticulations on the hinge margin show it to be distinct from any other species I am acquainted with, but the single impression of a left valve is not sufficient to characterize the species in a way that it can again be safely recognized. It is to be hoped that more and better specimens will in time be found.

Formation.—Ootatoor group.

YOLDIA, *Müller*, 1832, (see p. 420).1. YOLDIA STRIATULA, *Forbes*, Pl. IV, Fig. 2, and Pl. XVII, Fig. 6.

1846. *Leda striatula*, Forbes, Trans. Geol. Soc., Lond., vii, p. 148, pl. xvii, fig. 14.
 1847. „ *indica*, d'Orb., Voy. Astrolabe, Pal., pl. v, figs. 11-13.
 1850. „ *striatula*, Forbes, d'Orb., Prod. II, p. 236,—*eadem* auctorum.

Y. testa sub-quadrangulari, elongata, compressiuscula, inæquilaterali, antice paulo breviori et ad marginem rotundata, postice producta, subflexuosa, ad marginem late angulatim truncata, regione areali longa, planata, paululum concava, infra eam sulco haud profundo ab apice ad terminationem posteriorem extenso instructa; super-

ficie concentrice minute et confertim striata, umbonibus parvulis, approximatis; dentibus cardinis numerosis, fovea triangulari sub apicem divisis.

Height	of shell	:	its length	...	...	...	...	0.53.
Thickness	„	:	„	...	...	...	...	0.29.

This species is allied to the recent *Yoldia Thraciformis*, but is of smaller size and has the striation stronger. It seems to be a very rare shell, as only a single specimen of a left valve exists in our collection. I have, therefore, given an enlarged view of Forbes' original. As to general form the species would be taken for a *Neilo*, but it has distinctly a small cartilage pit below the umbo and no trace of a ligament.

Locality.—North of Karapady, in a soft coarse sandstone; Pondicherry.

Formation.—Arrialoer group.

2. *YOLDIA OBTUSATA*, *Stoliczka*, Pl. XVII, Figs. 7-10.

Y. testa ovato elongata, tumida, sub-inæquilaterali, antice sub-rotundata, postice paululum longiore, sub-truncata et prope marginem superiorem indistincter sulcata, lunula lata, medio paulo elevata, lateraliter applanata, concentrice confertim striata et nonnullis sulcis profundioribus prædita; cardine dentibus numerosissimis in utroque latere foveæ parvæ instructo.

Height	of shell	:	its length	...	...	...	...	0.66
Thickness	„	:	„	...	...	...	...	0.59

Easily distinguished from *Y. sub-recurva*, Phill., and other allied species by its more inflated form and very numerous and small hinge-teeth.

Locality.—Karapady, in soft, coarse, whitish sandstone; not common. A similar and perhaps identical species also occurs in the coarse sandstones near Streeparmatoor.

Formation.—Arrialoer group.

3. *YOLDIA SCAPHULOIDEA*, *Stoliczka*, Pl. XVII, Figs. 11-12.

Y. testa elongata, sub-tumida, sub-inæquilaterali, antice rotundata, postice sub-caudata, sensim attenuata et compressiuscula, sub-sulcata, margine areali concavo, area angusta, deplanata, umbonibus tumidulis, actiusculis, approximatis instructa; superficie concentrice confertim regulariterque striata; cardine dentibus numerosis prædito.

Height	of shell	:	its length	...	...	...	...	0.61
Thickness	„	:	„	...	...	...	...	0.35

This species is very like the Neocomien *Y. scapha*, d'Orb., but is distinctly less elongated. It differs from *striatula* by being more attenuated posteriorly, and from *obtusata* by being a much more compressed shell.

Locality.—Comarapolliam, in soft whitish sandstone; apparently rare.

Formation.—Arrialoer group.

XXXV. *Family*,—*NUCULIDÆ*.

Animal oval, with the mantle margins entirely open, with ciliated edges, which on the shorter, or posterior side, where the siphons should be placed, are a little longer than anywhere else; there are no distinct siphons present; gills elongated, unequal; labial palps rather large, sub-triangular, unequal, the upper shorter, thickened, and curled, the lower elongated and narrower; foot geniculate, expansible into a serrated disc, which can be folded together.

The shells are oval, produced anteriorly, very short, and sub-truncate posteriorly; hinge composed of two comb-like serrated or dentate hinge margins, ligament internal in a special pit, pallial line entire; internal layer generally strongly nacreous.

The *NUCULIDÆ* differ from the last family by the total want of special siphons and by the entire pallial impression; the shells are also readily distinguished by being very short posteriorly. Besides the recent species of *Nucula*, the shells of which are always pearly inside, there has lately been a peculiar shell made known under the name of *Sarepta*; it is of a more oval form (something like a short *Nuculana*), but not nacreous internally. The other characters are those common to *Nucula*, and it seems to me, therefore, that *Sarepta* may more appropriately be classed in this family than in the *NUCULANIDÆ*.

Fossil species of *NUCULIDÆ* occur in all formations, and their geological and geographical distribution is world-wide. There are at least 50 species known from the Palæozoics, about 30 from the Trias; the same number barely increases in the jurassic time, which is rather singular; 71 species are on record from cretaceous deposits, and somewhat more than one hundred from the tertiaries, while there are hardly more than about 40 recent species known. This decrease is remarkable as compared with the *NUCULANIDÆ*, in which we see an increase from the tertiary into the present period. The species live on muddy ground, in the tropical seas mostly between three and six fathoms, but are found at a much greater depth in northern seas.

a. *Sub-family*,—*NUCULINÆ*.

1. *Nucula*, Lam., 1799. Shell sub-trigonal or obliquely ovate, tumescent, inequilateral, posterior side very short and sub-truncate, anterior much produced and generally rounded at the end, surface usually smooth, covered with a thin olivaceous epidermis, highly nacreous within; hinge-line angulated and denticulated on both sides of the cartilage pit, which lies below the beak and extends anteriorly; sometimes there is a thin sub-external ligament present; type, *N. nucleus*, Linn.

1a. *Acila*, H. and A. Adams, 1857, has been suggested for the divaricately or angularly sculptured species, of which *N. divaricata*, Hinds, is the type.

b. *Sub-family*,—*SAREPTINÆ*.

2. *Sarepta*, A. Ad., 1860, (Ann. & Mag. Nat. Hist., 3rd ser., V, p. 303). Shell oval, equivalve, not pearly within; hinge-line nearly straight, provided with numerous denticles, cartilage internal below the beak; muscular impressions distant, pallial line entire; type, *S. speciosa*, A. Ad., from the Japan seas. "This

genus," says the author, "agrees with *Nucula* in the simple pallial line and internal ligament, and with *Malletia* in not being nacreous or pearly within, and in general form and character. It belongs to a distinct family between *NUCULINÆ* and *MALLETINÆ*."

It is possible that this is the recent representant of the fossil *Otenodonta*, connecting in many respects the *NUCULIDÆ* with the *NUCULANIDÆ*, for in those fossil forms the pallial line has not been shown to be sinuated, but the position of the cartilage or ligament has also not as yet been satisfactorily traced out.

3. *Otenodonta*, Salter, 1851, (Decade Geol. Surv., Great Britain, I; *Tellinomya*, Hall, ? ex-parte; see Meek and Worthen, Geol. and Pal., Illinois, iii, p. 308). This name has been proposed as a substitute for Hall's *Tellinomya*, but unless it has been shown that all the species described by Hall as *Tellinomya* possess the hinge-teeth of the *NUCULIDÆ*, which I greatly doubt, there is no sufficient reason for identifying both genera. Some of the *Tellinomyæ* noted by Hall and McCoy certainly are so extremely thin shells that they most improbably belong to the *NUCULIDÆ*. Taking *Oten. contracta*, Salter, as the type of the genus, it could be characterized as elongately oval, sub-equilateral, smooth, or finely concentrically striated, valves moderately convex, hinge represented by two diverging comb-like denticulated margins without a special hinge area between them and the beak, and below the latter not interrupted by a pit; ligament apparently external, posterior to the beak. From *Malletia* the shells would seem only to differ by a more elongated and more tumid form.

LIST OF CRETACEOUS SPECIES OF *NUCULIDÆ*.

Among the cretaceous *Nuculae* there are several somewhat elongated and nearly equilateral forms which appear to resemble *Sarepta*, but unless the internal structure of these shells has been properly examined no very correct generic determination can be attained. The numerous species from the German Pläner particularly require re-examination.

For reference of the first 29 species noticed see Pictet and Campiche in Pal. Suisse, III^{me} ser., 3^{me} part., p. 416 et seq.

1-13.—*N. planata*,* Desh., *simplex*,† Desh., *sub-triangular*,‡ Koch and Dunk., *ovata*, Mant., (non *eadem* Nilsson), *gurgitis*, P. and Roux, *Albensis*, d'Orb., *Timotheana*, P. and R., *Carthusia*, P. and R., *Arduennensis*, d'Orb., *pectinata*, Sow., *Jaccardi*, P. and Camp., *bivirgata*, Fitt., ? *ornatissima*, d'Orb.

The two last named species are referable to the sub-genus *Acila*.

14-28.—*N. impressa*, (= *Renaulxiana*, d'Orb.), *antiquata*, *obtusa*, *apiculata* of Sowerby, (*lineata*, Sow., is a *Nuculana*), *Ramondi*, d'Arch., *striatula*, Röm., (Nord. Kreid., p. 68, pl. viii, fig. 26, non *truncata*, Nilss.), *Reussii*, d'Orb., *sub-delloidea*, d'Orb., *concinna*, Sow., (1832)§ *Stachei*, Zitt., *redempta*, Zitt., *vox*, Gieb., (= *tenera*, Müll.),|| *ascendens*, Alth.,¶ *panda*,

* Why does d'Orbigny (Pal. franç. crét., pl. 300,) represent this and the two other species — *Cornueliana* (according to P. and Camp. only a variety of *planata*) and *simplex* — on the same plate with distinct fulera? Have these species an external ligament? or is it only a *lapsus penicilli* of the artist?

† Non *simplex*, A. Ad., 1856, a recent shell, the name of which must be changed.

‡ The identification with *sub-trigona*, Römer, appears very doubtful, but I also have no authentic specimens to compare.

§ Non *concinna*, A. Ad., 1856, which name must be changed.

|| Müller's figure does not appear to be very characteristic. A specimen of this species received from Dr. Bosquet shows a great similarity to Sowerby's *impressa*, but this is a decidedly slender and more elongated form.

¶ Vide Favre Desc. M. foss. de Lemberg, 1869, p. 119.

* But it has been clearly shown that the type species, and all others of the genus, have crenate hinges, and belong near *Nucula*. It is to be regretted that H.S. has been troubled by so many doubts in regard to the conclusions of nearly all others about the genera of shells.

Nilss., *nana*, Röm.* (1841). This last species is very unsatisfactorily characterized; it may prove to be identical with either *Leda Försteri* or *Hagenovi* of Müller. It was originally described from a little cast from the cretaceous beds at Aachen, but neither Müller nor Bosquet allude to it in their publications subsequent to those of Römer.

29.—*N. truncata*, Nilss. (Favre, Desc. M. foss. de Lemberg, 1869, p. 120). This closely resembles *striatula*, Röm., (see also Reuss in Böhm. Kreid., pt. ii, p. 5).

30.—*N. denudata*, Reuss (= *N. ovata*, Nilss., Pet. Suec., 1827, p. 16, non *eadem* Mantell, 1822). This species is quoted by Bosquet from the Maastricht beds under Nilsson's name; it is quite different from Mantell's species. Reuss designated it with a special name, but subsequently (Böhm. Kreide., part ii, p. 6,) identified it by mistake with Sowerby's *impressa*.

31.—*N. pulvillus*, Müll., Mon. Pet. Aach. Kreid. Supp., 1859, p. 11. This species also very closely resembles *striatula* of Römer.

32-35.—*N. concentrica*, Fisch., *interstriata*, Eichw., *macrodon*, Eichw., *dilata*, Eichw., are described (in Leth. Geog., 1867, xme liv., p. 585 et seq.) from the cretaceous rocks of Russia. Eichwald mentions besides *impressa*, Sow., *producta*, Nilss., (*Leda*) *pectinata*, Sow., *ovata*, Mant., and *Renauxiana*, d'Orb., the last of which he identifies with Trautschold's *N. Oppeli*.

36.—One small species is figured by Guéranger (in his Album pal. de la Sarthe, 1867, pl. xx, fig. 16,) under the name of *impressa* of Sowerby, but it is unquestionably distinct from this. It is either a small form of *antiquata*, Sow., or a new species; it also exhibits marked relations to our *N. crassicula* from Southern India.

37.—*N. Dewalquei*, Briart et Cornet, (Mem. Cour. Acad. Belgique, xxxiv, Fossiles de la Meule de Bracquegnies, p. 62,) belongs to the sub-genus *Acila*.

38-40.—*N. Mauritanica*, *cretacea*, and *Desvauvi* are described by Coquand from Algiers. (Prov. Const., p. 211).

41-42.—*N. incerta* and *Albertina* of d'Orbigny are from South America.

43-55.—*N. cancellata*, M. and Hayd., *bellastriata*, Sh., *cuneiformis*, Con., *distorta*, Gabb, ? *æquilateralis*, M. and Hayd., *Haydeni*, Sh., *obsolete-striata*, M. and H., *percrassa*, Con., *peræqualis*, Con., *planimarginata*, M. and Hayd., *serrata*, Sh., *subplana*, M. and H., *Traskana*, Meek, are recorded in Meek's Check-list, (Smiths. Misc. Coll., No. 177, p. 8,) from North America.

56.—*N. Conradi*, Meek, in Conrad's Check-list of eocene fossils (Smiths. Misc. Coll., No. 200, p. 4).

57-58.—*N. [Acila] truncata*, Gabb, (Pal. Calif., I, 198, and II, 197,) non = *truncata*, Nilss., et non *N. truncata*, Brown (= *Nuculana glacialis*, Gray ex Leach), and *N. solitaria*, Gabb, (P. Calif., II, p. 197,) are described from the Californian cretaceous deposits.

59-65.—*N. perovata*, *submucronata*, *parallela*, *syriaca*, *myiformis*, *perobliqua*, and *abrupta* are described by Conrad in Off. Rep. of Lynch's Exped. to Palæstine; the last is considered by Fraas to be identical with d'Orbigny's *Renauxiana* = *impressa*, Sow., (vide Würt. Nat. Jahresh., xxiii, 1867, p. 236). Fraas also mentions *N. Cornueliana*, d'Orb., which Pictet and Campiche consider to be a variety of *planata*, Desh.

66-67.—*Nucula maxima* and *triquetra* are described by Schafhäutl from cretaceous beds of Bavaria (Süd-Bayerns Leth. Geog., 1863, p. 159). Of the first the description and figure are so insufficient that no opinion can be formed about the fossil; the second appears very closely allied, and probably identical with Zittel's *Stachei*. Schafhäutl on p. 374 of the same work gives again a *N. triquetra*, Goldf., from beds with *Inoceramus mytiloides*. Goldfuss describes a *triquetra*, Münst., which name is substituted in the "errata" for *N. trigona* noted in the text, but this species is said to be from the Lias and L. Oolite, and is certainly quite different from Schafhäutl's shell.

68-72.—*N. Tamulica*, *indefinita*, *sp. ind.*, *crassicula*, and *bidorsata* occur in the South Indian cretaceous rocks.

* Non *N. nana*, Hinds, 1843, a recent, but doubtful species.

NUCULA, *Lamarck*, 1799, (see p. 325).1. NUCULA TAMULICA, *Stoliczka*, Pl. XVII, Figs. 15-16.

N. testa ovata, valde inæquilaterali, antice producta et sub-rotundata, postice brevissima, oblique truncata, area applanata et longa instructa, compressiuscula, umbonibus obtusiusculis, approximatis, incurvis; superficie concentrice minute striata, sulcis nonnullis crassioribus ad marginem prædita.

Height	of shell	:	its length	...	...	...	...	0.73
Thickness	„	:	„	...	...	...	...	0.44

This species belongs to the type of *Deshayes' simplex*, largely represented in cretaceous rocks, but distinguished by its perfectly truncated posterior end and flat, or along the middle almost excavated, area. It in this respect resembles *N. vox*, *Gieb.*, (*tenera*, *Müll.*) from the Plæner beds at Aachen, but this species is again distinguished by its radiating striation, which is always more or less distinctly traceable.

Localities.—Karapaudy, Comarapolliam, and Olapaudy, in a soft, whitish and coarse sandstone.

Formation.—Arrialoore group.

2. NUCULA INDEFINITA, *Forbes*, Pl. XVII, Figs. 17-19.

1846. *Nucula indefinita*, *Forbes*, Trans. Geol. Soc., Lond., vii, p. 148, (passim).

N. testa ovata, sub-tumida, antice sub-rotundata, supra ac infra lente curvata, postice brevissima, truncata, area mediocri, paulo excavata, haud distincter marginata, umbonibus prominulis; superficie concentrice minute striata; dentibus cardinis anterioribus circiter 14, crassis, impressione musculari postica valde elongata, elevata, marginali.*

Height	of shell	:	its length	...	...	...	...	0.70
Thickness	„	:	„	...	...	...	...	0.50

Forbes proposed the name for a small cast of this species, very like the one represented in fig. 18,† pl. xvii, which is from *Cunliffe's* collection of Pondicherry shells. It is a small species of a slightly more elongated and tumid form than *Tamulica*, and has the area shorter, somewhat excavated, and indistinctly margined. The posterior muscular impression is very elongated, marginal, and situated on a thickened plate, forming a deep excavation on the cast.

Localities.—Pondicherry, in a bluish sandstone; Ninnyoor, in a white sandy limestone; only one specimen from each locality was examined.

Formation.—Arrialoore group.

* In fig. 17 the inferior end below the lunula is a little too much produced.

† The beaks should be a little less prominent.

3. NUCULA, *sp. ind.*, Pl. XVII, Fig. 20.

The figure represents an evidently larger and more sub-trigonal shell than *N. indefinita*; the anterior muscular impression is very faint, the posterior somewhat better marked and rounded; the cast shows 18 anterior and 10 posterior teeth on the hinge-margin; the latter are longer, but thinner than the former, and the denticulation is barely interrupted under the beaks by a pit which must be small and situated quite internally.

Locality.—Odium; only the single figured cast specimen was found, and as there are no traces of the shell surface preserved, I will not now designate it with a specific name; it bears some relation to Nilsson's *ovata*.

Formation.—Ootatoor group.

4. NUCULA CRASSICULA, *Stoliczka*, Pl. XVII, Fig. 23.

N. testa sub-trigona, crassiuscula, moderate tumida, supra lente, infra majus convexa, antice ad terminationem angustatim rotundata interdumque sub-angulata, postice brevissima, oblique truncata, area haud distincter marginata, latiuscula, ad medium paulo elevata; superficie striis concentricis crassiusculis, confertissimis, nonnunquam 2-3 sulcis profundis distantibus ad medium et ad peripheriam sitis, et striis radiantibus minutis plus minusve distinctis intersectis notata; cardine multi-dentato, dentibus fovea parva infra umbones sita interruptis; margine interno crasse denticulato.

Height of shell	:	its length	...	...	...	0.75 - 0.78
Thickness	„	„	...	...	...	0.41 - 0.46

This is a remarkably strong shell as compared with its size, and some specimens are conspicuously more convex than the one figured. The very close concentric striation is often interrupted about the middle and near the periphery with two or three deep furrows; they only indicate stages of growth, and are, therefore, occasionally absent. A fine radiating striation is also traceable on the entire surface in well preserved specimens, but in others it remains only posteriorly distinct, or in the furrows separating the concentric striæ. The internal pearly layer is externally very finely striated.

Locality.—Karapady, in whitish coarse sandstone; not uncommon.

Formation.—Arrialoor group.

5. NUCULA BIDORSATA, *Stoliczka*, Pl. XVII, Figs. 22, 24-27.

N. testa parvula, elongato ovata, antice late rotundata, postice brevissima, oblique rotundate sub-truncata, area ad medium valde prominente; valvis paulo convexis, superficie concentric et radiatim crasse striata; margine interno denticulato; cardine dentibus numerosis, parvulis, fovea infra umbones interruptis, instructo.

Height of shell	:	its length	...	...	...	0.74
Thickness	„	„	...	...	...	0.35

This species is closely allied to the last, but it is more regularly ovately elongated, somewhat more compressed towards the margins; the area is less truncate and

more prominent along the median line where the two valves meet, and the striation is as compared with the size of the shell coarser. The shell consists of two distinct and easily separable layers; the outer, thick, calcareous, which exhibits the above noted ornamentation, and the inner, thin, pearly layer, which is radiately striated externally and smooth internally, only the inner peripheral margin being denticulated. When the upper calcareous layer of the shell is removed and the pearly one preserved, it would be hardly possible to identify both (see figs. 24 and 25),* if their connection was not verified by other specimens which have portions of the upper layer still preserved. Again, when both the calcareous and pearly layers are removed, the cast appears as a quite smooth shell.

This is a sufficient exemplification of the value to be attached to species which are described only from imperfect casts. They are *sensu stricto* useless.

Locality.—Moraviatoor, in dark earthy limestone.

Formation.—Ootatoor group.

XXXVI. *Family*,—*ARCIDÆ*.

The mantle is separated in its entire extent, generally with fringed edges, sometimes provided with small ocelli, which appear to represent eyes. As a rule, the edge of the mantle is double; the outer is thin, entire, and secretes the epidermis; the inner is thicker, crenated, or undulated, and if any ocelli are present they are placed on the outer side of this inner edge. The foot is large, geniculate, more or less extensile into a disc and anteriorly generally somewhat produced, below often grooved, posteriorly truncate with or without a byssus; the palps are said to be short and represented by merely detached portions of the branchia, which are two in number on either side, consisting of numerous rather loose filaments; they are generally very large and sub-equal; there are no special siphons present.

The shells are round or oval and elongated, with an external ligament usually attached to a special flattened and grooved area below the beaks, sometimes concentrated in a single pit; the hinge is composed of numerous cross sub-equal teeth, fitting alternately beside each other; two large muscular impressions, pallial sinus entire.

There are two somewhat different groups or sub-families to be distinguished, *AXINÆINÆ* (= *PECTUNCULINÆ*) and *ARCINÆ*. The former more resemble the previous families than do the latter. The animals of the *AXINÆINÆ* have a short foot with a broad disc and without a byssus. The shells have the hinge-teeth always arranged in a curved unbroken series, equal on both sides, but as regards the form of the shell and the development of the ligament they partially greatly resemble *NUCULIDÆ*. The genera referable to the sub-family are *Nucunella*, *Trigonocælia*, *Limopsis*, *Cyrilla*, *Nucinella*, *Axinæa*, and *Lyrodesma*. Of these the fossil *Trigonocælia* strongly recalls the shape of some of the *NUCULANIDÆ*; its ligament is sub-external, and *Cyrilla* appears to be its recent representative; *Nucinella* has

* This valve has somewhat suffered by accidental pressure, and appears, therefore, flatter and more produced above, than the shell would be in its perfect state.

the shape of *Nucula*, but the cardinal teeth similarly distributed as in *Axinæa*; *Limopsis* has the ligament of *Trigonocælia*, but the round shape of *Axinæa*, and *Lyrodesma* is a peculiar palæozoic fossil with the hinge-teeth somewhat similarly disposed as in *Trigonocælia*; the external characters are, however, insufficiently known.

In former geological periods the *AXINÆINÆ* were scarce; they appear to have been more varied as regards generic forms, but most of those remarkable types have again died out, and only *Limopsis*, *Cyrilla*, and *Axinæa* have continued up to the present time. Still researches in the deep waters of tropical seas may supply many of the missing links, as has only recently been proved by the discovery of *Cyrilla*. *Lyrodesma* is, as already noticed, palæozoic; *Limopsis* occurs in the Trias and continues up to the present time; *Trigonocælia* and *Nucinella* are known from cretaceous and tertiary deposits; *Nucunella* only from the latter; the occurrence of *Axinæa* in palæozoic rocks is somewhat uncertain, the few forms known are not typical, but from the beginning of the Trias the genus occurs through all the subsequent formations and attains its maximum of development at the present time.

The *ARCINÆ*, as restricted, do not exhibit equally marked relations to the *NUCULIDÆ*, as has been shown to be the case with the former sub-family. The animals have a more elongated, geniculate foot, posteriorly often provided with a byssus, which is usually solid at its base and divided into filaments at the end. It is a most important organ in the economy of the animal and used for obtaining by it a fixed position in crevices and hollows of rocks, sometimes exposed to the heaviest attacks of the waves. The animal can, however, detach itself at will from its resting place, evidently by absorbing or dissolving the terminal filaments of the byssus. The byssal mass is implanted in a strong muscular tissue at the posterior, generally strongly compressed, part of the foot; it appears to be almost quite solid at its base, but on close inspection the single threads can always be recognised, and towards the end they are, as already stated, generally quite distinctly separated. Not all the genera of *ARCINÆ*, however, possess a byssus; most of the species of *Arca* and *Barbatia*, &c., have it largely developed; those of *Scapharca* apparently less, and in some species of *Anomalocardia* it is altogether absent. Other organs appear to be equally variable. To illustrate this I shall note three species which I have lately examined:

Anomalocardia rhombea, Born, from the Arracan coast. Foot large, roundly oval, compressed, anteriorly slightly bent forward, expansile into an oval disc, with undulating edges, capable of being folded together when retracted within the shell; posterior part of the foot sharp with no trace of a byssus; gills large, broadly sickle-shaped, filaments close together. There is a pair of gills on either side, but each may be said to be again double: the basal portion is strongly fleshy, and the peripheral filaments are as if bent outward on either side of each leaf, so as to form a duplicature, returning almost to the base, but not grown to it. Very likely these duplicatures are used for hatching eggs. Palps large, elongately semioval, quite separated from the gills, internally striated, the upper

a little larger than the lower, and connected across the front by a distinct broadish lamina; no distinct ocelli to be observed at the edge of the mantle.

Barbatia Helblingii, Brug., from the Nicobars. Foot very large, strongly compressed, anteriorly slightly produced, and expansile into a small disc, with undulating edges, folded together when retracted; posterior part of the foot provided with a very strong byssus, thin and solid at the base, expanded and fibrous at the end; gills very large, consisting of rather loose long filaments, each leaf of each pair bent outwardly so as to make a free duplicature; palps very narrow throughout and long, originating near the anterior end of the gills, but distinct from them, thin, almost equal, internally finely striated; inner edge of the mantle externally with a few ocelli at the antero-ventral gape of the shell.

Scapharca gubernaculum, Reeve, dredged in 2-4 fathoms near Penang. Foot compressed, strongly produced anteriorly, and expansile into a long oval disc, with undulating edges, capable of being folded together, posterior part much compressed, with a moderately thickened long byssus, of a somewhat lamellar structure; gills elongated, semioval, each leaf duplicated, and consisting of close filaments; palps large, sub-semicircular, the outer slightly larger than the inner, both internally striated and perfectly separated from the gills; no distinct ocelli at the mantle edge.

The form of the palps appears to be very variable, though it seems to be to a certain extent constant for the different genera. In all the specimens which I saw each leaf of the gills was folded in the manner above described; I do not find a special mention of this character elsewhere; it seems, however, to be most characteristic.

The shells always have an elongated trapezoid or sub-triangular form, closed all round or gaping on the anterior part of the ventral side, with the hinge margin more or less straight and provided with numerous sub-equal teeth. The genera which I have here placed in the sub-family are: *Cardiola*, *Cypricardites*, *Bakewellia*, *Macrodon*, *Grammatodon* (sub-g. ?), *Nemodon*, *Cucullaria*, *Cucullæa*, *Trigonoarca*, *Latiarca*, *Noetia*, *Lunarca*, *Isoarca*, *Argina*, *Senilia*, *Anomalocardia*, *Scapharca* (sub-g. ?), *Nemoarca*, *Barbatia* (with sub-g.—*Cucullæarca*, *Acar*, *Calliarca*, *Striarca*, and *Litharca*), *Arca*. Each of these possesses some peculiarities in the form and arrangement of the hinge-teeth, as will be seen by a comparison of their characteristics given further on, but all are not sufficiently well defined, and close comparison of the fossil species may greatly reduce the newly proposed generic or sub-generic divisions. Deshayes, as usually, strongly objects to assail the unity of *Arca*, but proposes several sub-divisions which have a somewhat similar extent and the same object as these genera.

Arca and *Barbatia* are already found represented in the silurian rocks, and from that time the variety of forms and number of species increases until the cretaceous period, where the *ARCINÆ* appear to have attained the maximum of development. With the cretaceous period several forms, like *Macrodon*, *Nemodon*, *Isoarca*, and a great many others, have entirely disappeared. In the whole of the tertiary period the number of generic forms and of species seems to be hardly equal

to that of the cretaceous alone, and certainly it is not larger, while that of the present epoch again seems to have somewhat decreased. I would estimate the number of species of the *ARCINÆ* in the whole of the palæozoic period to be about 50; in the Trias about 40; in the Jura barely 80; from the cretaceous 240 are now on record, from the eocene about 120 are known, from the miocene, oligocene and pliocene about 100, and recent there are about 180 described. The general conclusions based upon these figures can of course be accepted only as approximately correct, for there are not nearly so many additions to be expected in the recent as in the fossil fauna.

With reference to the distribution of the recent species, I hardly need to remark that the tropical seas contain by far the larger number. Most of the species are truly marine shells, only a few are found in brackish water, and even *Scaphula*, which is generally quoted as a mere freshwater inhabitant, seems quite as common, if not more common, in the brackish waters of the delta of the Irawadi, as where it occurs in the Ganges near Monghyr, (see Blanford, Jour. As. Soc., Bengal, xxxvi, pt. II, p. 70).

a. *Sub-family*,—*AXINÆINÆ*.

1. *Nucunella*, d'Orb., 1850, (Prodrome de paléont., ii, p. 389).^{*} Shell sub-orbicular, slightly inequilateral, beaks close together; hinge line curved with numerous cross pliciform teeth, interrupted under the beaks by an oblique simply granular pit, this last appearing to be destined for the ligament, which must at least partially be internal; type, *N. Nystii* (*Stalagmium Nystii*, Galeotti), from tertiary beds of Belgium. This appears to be quite distinct from *Limopsis*, but I am not certain of the distinction from *Myoparo* or *Stalagmium*. Chenu (Man., ii, p. 181.) quotes a *N. aviculoides* of d'Archiac, which is either a peculiar form of a *Cucullæa*, or else a distinct genus of the *ARCIDÆ*. Lea (Cont., p. 73,) does not say in his characteristic of *Myoparo* (1833) whether the type species, *M. costatus*, has an internal cartilage pit, but the figure seems to indicate one, quite similar to that of *N. Nystii*, and this makes the identification problematical.

2. *Trigonocælia*, Nyst and Galeotti, 1835. Shell sub-trigonal, inequilateral, or nearly so, posterior declivity carinated and usually pointed at the end; hinge line small, curved, with numerous cross-teeth; no separate hinge area above it, but a small cartilage pit is situated immediately below the beak; type, *T. inæquilateralis*,† d'Orb. Deshayes, I think, properly reserves Nyst's name for the triangular forms, which on account of the want of a special hinge area mostly approach the *NUCULIDÆ*.

3. *Limopsis*, Sassi, 1827, (*Pectunculina*, d'Orbigny). Shell sub-orbicular, sub-equilateral; hinge line curved and provided with a series of cross-teeth, a small hinge area below the beaks provided with a triangular pit in the middle, sometimes

^{*} D'Orbigny gives 1847 as the date of publication of the name, and refers to his Cours de paléontologie, which (Vol. II) bears the date of 1852, while the Prod. was published in 1850. Chenu writes *Nuculella*, but this name was not used by d'Orbigny in any of the publications noted above.

† Not *inæquivalvis*, as quoted by Chenu.

partially intercepting the dental series; type, *L. multistriata*, Forsk. Zittel (Denksch. Acad., Wien, xxiv, pt. 2, p. 165,) says that the first species of this genus occurs in the Trias of the Alps. The number of species increases very gradually in the subsequent formations, but it is difficult to say whether the species are at present more numerous than they were at any other time. A. Adams described in Proc. Zool. Soc. for 1862, p. 229, nine recent species belonging to this genus, chiefly from the China and Japan seas, and if other regions should prove to be equally prolific, the genus would have its maximum of development in the present time.

4. *Cyrella*, A. Ad., 1860, (olim *Huxleya*, A. Ad., Ann. Mag. Nat. Hist., 3rd ser., v, p. 303 and p. 478). Shell oblong, oblique, very inequilateral, covered with a thin epidermis; hinge with six diverging sharp teeth, directed posteriorly and terminating with a curved lamina; ligament situated in a small pit under the beak; type, *C. sulcata*, A. Ad., from the Straits of Korea, "dredged from 63 fathoms." This appears very much to recall the typical forms of the fossil *Trigonocælia*, (as restricted), but the hinge-teeth seem to be peculiar and few in number. However, a close comparison between the two shells would be very desirable.

5. *Nucinella*, S. Wood, 1850, (Crag. Moll., II, p. 73, *Pleurodon*, Con., *Nuculina*, D'Orbigny). Shell obliquely ovate, inequilateral, being anteriorly somewhat produced, closed, no perceptible hinge area; hinge line curved with numerous cross-teeth not interrupted in the middle, and an elongated anterior lateral tooth, single in the right, double in the left, valve; muscular impressions unequal, ovate, anterior slightly larger; ligament very small, external, posterior to the beaks; type, *N. ovalis*, Wood,* from miocene beds of the Vienna basin, and from the crag beds of England. One species also occurs in our South Indian cretaceous deposits.

6. *Axinæa*, Poli, 1791, (*Pectunculus*, Lam., 1801). Shell solid, sub-orbicular, sub-equilateral, or slightly oblique, more or less tumid; hinge area distinct, striated and covered with ligamental mass; hinge line curved with numerous pliciform cross-teeth, sometimes partially obsolete in the middle; muscular scars sub-equal, ovately elongated, strong, generally on somewhat raised plates; type, *A. glycimeris*, Linn.

H. and A. Adams reserved Lamarck's name *Pectunculus* sub-generically for the radiately ribbed species, but I do not think that the distinction can be upheld. The fossil forms offer all stages of variation in this point of ornamentation.

7. *Lyrodesma*, Con., 1841, (Ann. Geol. Report, p. 51, and Hall in Pal. of New York, 1847, I, p. 302, *Actinodonta*, Phil.). Shell equivalve, inequilateral, anteriorly shorter and rounded, posteriorly obliquely truncate, "hinge with about eight diverging prominent cardinal teeth, transversally striated;" type, *L. plana*, Con., from silurian rocks of North America. M^cCoy (Pal. foss., &c., p. 272, pl. I k,

* The figure of *Modiola analoga*; Deshayes (Par. foss., pl. 74, figs. 27-29), would indicate that the species rather belongs to *Nucinella* than to *Crenella*. It is certainly not a *Modiola*, though it may be a *Modiolaria*.

fig. 17,) describes the same species from corresponding rocks of N. Wales. According to his figure the hinge area is rather broad and instructed with seven elongated ribs, diverging in a semicircle, indicating a peculiarity of the hinge distinct from any other genus of the *ARCIDÆ*. Consequently the other species referred by Hall to the same genus, *L. pulchella* (ibidem, p. 302,) is generically different from the former, as was suspected by that author; it may perhaps belong to *Ctenodonta*. Another species of *Lyrodesma* is, however, *Nuculites poststriata*, Emmons, (Hall, l. cit., p. 151 and p. 301). Judging from the above characters, the only known forms allied to *Lyrodesma* are those of the recent *Cyrella* and the tertiary *Trigonocælia*.

Lyrodesma would seem to connect the *AXINÆINÆ* with the *ARCINÆ*.

b. *Sub-family*,—*ARCINÆ*.

1. *Cardiola*, Broderip, 1834, (*vide* Sandberger, Rhein. Schichtensystem in Nassau, 1850-56, p. 269). Shell somewhat inequilateral or sub-equilateral, roundly ovate, with the beaks incurved anteriorly and with a rather large ligamental area between both; hinge line slightly curved with numerous oblique pliciform teeth, being apparently present on both sides of the beak; surface generally radiately striated or ribbed; type, *C. retrostriata*, Buch. All the species are from palæozoic beds; their hinge-teeth have as yet been only partially traced, and the characteristic of the genus is therefore unsatisfactory. In some species the hinge-teeth appear to be similarly disposed as in *Lyrodesma*, in others they seem to be similar to those of *Cypricardites*. Much better materials than those now on record are required for a proper definition of *Cardiola*; in external form it mostly recalls the recent *Argina* and *Lunarca* of Gray.

2. *Cypricardites*, Con., 1841, (Palæarca, Hall, 1858, Pal., New York, vol. iii, pp. 271 and 523, *Cyrtodonta*, Billings, et *Vanuxemia* apud Billings, *ex parte*). Shell elongately or roundly ovate, tumid, inequilateral, the beaks being almost anterior and incurved; hinge area narrow or sometimes apparently almost obsolete; hinge line rather straight, with a few (usually 4-6) short oblique teeth in front and sometimes near the umbones, and a few (1-4) elongated nearly horizontal teeth at the posterior end; type, *Cyp. ventricosa*, Hall. All the species appear to be confined to the palæozoic rocks. The character of the hinge-teeth of *Cypricardites* shows relations to *Macrodon*, and the former may be considered as the predecessor of the latter in geological history. Probably some of the species described as '*Cypricardia*' from the Devonian and Permian rocks belong to the present genus.

3. *Bakewellia*, King, 1848, (Perm. foss. of England, &c., 1850, p. 166). The form of the shell of this genus is very similar to *Cypricardites*, except that the posterior upper edge is somewhat more expanded, wing-like, the shell, therefore, closely resembling a small *Avicula*; the hinge area is broad, and the ligament apparently situated in several obliquely transverse grooves, hinge line straight, internally with a few short, oblique anterior, and 1-3 nearly horizontal, elongated posterior teeth, as in *Cypricardites*; type, *Mytilites ceratophagus*, Schlotheim. It

seems to me somewhat doubtful that this genus is distinct from the last, at least as regards some of the species. I have preferred to class it provisionally in the present family, rather than in the *AVICULIDÆ*, because *Bakewellia* has the anterior muscular scar very distinct, while all species of the latter family have it very indistinct, or obsolete. Geinitz identifies *Bakewellia* with *Gervillea*, and this may in part be quite correct, but whether the typical species bear out that identification remains yet to be satisfactorily ascertained.

4. *Macrodon*, Lycett, 1845, (*vide* Moll. Great-Ool., &c., 1853, pt. ii, p. 48). Shell elongately sub-rhomboidal, with the umbones sub-anterior, incurved; rather tumid, hinge area large, striated for the attachment of the ligament; internal hinge line straight, as long as, or little shorter than, the shell, anteriorly with numerous short, unequal, oblique teeth, posteriorly with a few sub-parallel long teeth, often more or less distinctly transversally crenated; type, *M. Hironensis*, d'Arch. The species of *Macrodon* are mostly from jurassic rocks, but a few also occur in the Trias, and some others are from cretaceous deposits.

5. *Grammatodon*, Meek and Hayden, 1860, (Proc. Phil. Acad., 1860, p. 419). This genus is based upon a jurassic Nth. American species, described by the authors in Proc. Phil. Acad. for 1858, p. 51, as *Arca (Cucullæa) inornata*. The form appears to be very much like that of a somewhat elongated *Cucullæa*, and so also the hinge, except that the anterior teeth are slightly oblique: the posterior muscular impression seems not to be raised upon a projecting "lamina," while it is so in *Cucullæa* and *Macrodon*. The last statement is evidently doubtful, and if, as I suspect, *Arca inornata* differs as slightly from *Macrodon* as does our *Macrodon Japeticum* from *M. disparile*, I doubt whether there is sufficient ground for even sub-generically separating the form in question.

6. *Nemodon*, Con., 1869, (Am. Journ. Conch., V, p. 97). Elongated in form, resembling *Macrodon*, but of thin structure; hinge area very narrow, hinge line long, straight, or slightly curved under the beaks, "with three linear teeth parallel with the anterior cardinal margin" in the left valve, and with a double posterior lateral tooth, being very long and linear; under the beaks a few granular teeth are present; type, *N. Eufalensis*, Conrad. This appears to be a very narrowly defined characteristic of a genus, and I have some doubt whether it will be proved to be sufficiently distinct from *Macrodon*, with which the form of the shell entirely agrees. There are some jurassic *Macrodon* known with a few small teeth under the beaks, and they differ from *Nemodon* only by having the anterior teeth obliquely placed. The next genus is equally allied to the present one, the hinge being almost identical in both, but the former has the shape of a shell of *Barbatia*, while that of the latter agrees with *Arca*. A further uncertainty exists as to the name of the species. Is *Nem. Eufalensis* the same species as *Arca (Macrodon) Eufalensis*, Gabb, which Mr. Conrad quotes as generically the same with *Trigonoarca Maconensis*, Con., (see p. 346)? From Conrad's quotation at least this would appear to be the case, but his figure does not represent the same shell as that described by Gabb. Probably Conrad refers to Gabb's species only *ex parte*.

* *Bakewellia* seems to vary in the size of the anterior muscular scar, some species, such as *B. pinnoides*, *B. longicosta*, having it very small or nearly obsolete. The affinities of the genus are to the *Aviculidæ*. As the considerable *Stoliczka*, should have referred *Bakewellia* to the *Aviculidæ*, in which it certainly belongs, or, at least, to some other family than the *Cardiidae*, which he merely mentions it under *Hemicardium*, as if he did not consider it was sufficiently distinct from that genus.

† It is to be regretted that the *St.* should have been troubled by so many doubts in regard to nearly all new genera not proposed by himself. The casts of the interior of the type of *Grammatodon*, show clearly and distinctly, that it has no elevated or otherwise defined plate connected with its posterior muscular scar. *Stoliczka* certainly did not use my description of the hinge of *Grammatodon* very carefully, or he would not have so dubiously referred to it such a shell as that described by him on p. 350, belonging to an entirely distinct type.

7. *Cucullaria*, Desh., 1860, (Paris foss., 2nd edit., p. 906). Elongated, sub-oval, moderately inflated, radiately striated, inequilateral, beaks sub-anterior, incurved, very close together, the hinge area being very narrow and almost wanting in some species; hinge line moderately curved with a few shorter anterior and some longer posterior fold-like teeth, arranged almost parallel to it; numerous sub-equal teeth are situated below the beaks; type, *Arca heterodonta*, Desh., from the Paris basin. Most of the species of this apparently well marked type are from eocene deposits; its form agrees with *Barbatia*, as already noticed. Deshayes describes a few species, like *margaritula* and *decipiens*, which should also be placed in this genus, though he does not associate them with his "*Cucullaires*."

8. *Cucullæa*, Lam., 1801. Shell trapeziform, sub-quadrangularly elongated, rather ventricose, generally somewhat inequivalve, sub-inequilateral, with the beaks incurved and distant; hinge area for the attachment of the ligament broad and angularly striated; hinge line straight, in the middle provided with a few small cross or slightly oblique teeth, the outermost bending outwards and prolonged more or less parallel to the hinge line; both, or only the posterior muscular impression, are situated on an elevated plate; type, *C. concamerata*, Martini.

Laube (Denk. Acad., Wien, xxv, pt. ii), Strombeck and others have referred a few triassic species to *Cucullæa*, but the form of most of these agrees better with *Anomalocardia* and *Noetia* than with the above-named genus. Characteristic species of *Cucullæa*, however, occur in the Lias and Jura, and during the cretaceous period their number appears to have been largest. Few are known from tertiary deposits, and only three are found recent in the eastern seas.

9. *Trigonoarca*, Con., 1867. Among the cretaceous forms there is a peculiar group of species distinguished, the shells of which mostly resemble *Cucullæa*, except that they are of a more solid structure and of a somewhat more oblique form; their surface is concentrically and radiately striated, the concentric striæ being often more distinct than the radiating ones, which become occasionally obsolete; the posterior muscular impression is on an elevated plate, as in the former genus, the hinge line is also quite similar to *Cucullæa*, but the hinge-teeth are very numerous, and all are placed as if radiating from the centre. Those in the middle are almost vertical, and towards either end they gradually increase in length and turn more and more outward, retaining, however, their oblique position, at least on the posterior side, while on the anterior one they occasionally become almost horizontal. This character of the hinge very strongly recalls that of *Noetia*, and I am not quite sure whether *Trigonoarca* should not be regarded as a sub-genus of it. The shell of the former appears, however, to be often more elongated, less distinctly radiately costate, and the dental hinge line does not form an angle near the middle, while this seems peculiar to *Noetia*. On the whole, *Trigonoarca* equally resembles *Cucullæa*, as *Noetia* approaches *Anomalocardia*; but in all the three last named genera the hinge-teeth are either placed vertical to the hinge line or they are descending on both sides, not ascending.

Conrad (Am. Journ. Conch., III, 1867, p. 9), quotes *T. Maconensis*, Con., from North American cretaceous beds as the type of *Trigonoarca*, (see Journ. Phil. Acad., 2nd ser., iv, pl. 47, fig. 20). *Arca Ligeriensis*, d'Orb., would be a still better example. The cretaceous species are very numerous, and many show considerable variations in the hinge-teeth. Some, like *A. Marreana*, d'Orb., appear to indicate a direct transition to *Cucullæa*. It is possible that the so-called *Cucullæa polyglypha*, Laube, from the triassic beds of St. Cassian also belongs to this genus. It only differs by having the surface costated (see Denk. Akad., Wien, xxv, pt. ii, p. 62); it may, however, also be referable to *Noetia*.

10. *Latiarca* was described by Conrad in Proc. Phil. Acad., 1862, p. 289. Unfortunately the first portion of this publication for that year appears to have gone astray, for in our own library, as well as in the Asiatic Society's, the volume for 1862 remains incomplete up to date. The reference to the genus in Am. Journ. Conch., I, p. 11, leaves me in doubt about the characteristic which Conrad assigns to it. He quotes from lower eocene (? cretaceous) beds three species, *L. gigantea*, *ononcheila*, and *transversa*. The description and figure of the first, in Journ. Ac. Nat. Sc., 1st ser., vi, p. 227, pl. 10, fig. 4, are so incomplete that no certain opinion can be based upon them. Conrad says, the anterior side is flattened and produced, the posterior very short, but the figure appears to indicate the type of a shell which resembles a short *Cucullæa*, or perhaps a *Noetia*. The reference to the two other species is also not accessible to me at present.

11. *Noetia*, Gray, 1842. This genus, with *N. reversa*, Gray, as type, seems to represent in the recent fauna the group of fossil shells to which I have just pointed as *Latiarca*, and possibly both may be the same, but I have none of the recent species to compare. Their form is sub-trigonal, ventricose, sub-inequilateral, radiately ribbed, and covered with a dark foliaceous epidermis; the ligamental hinge area is narrow, but distinct, the hinge line slightly arched, with transverse oblique teeth placed so as to converge towards the centre of the shell; these teeth are more numerous on the anterior than on the posterior portion of each valve.

12. *Lunarca*, Gray, 1842. Shell globose, cordiform, sub-equivalve, with the beaks incurved and close together, the ligamental hinge area being very narrow and almost absent, surface radiately ribbed; hinge line angular, posterior part nearly straight, long, and provided with numerous short transverse teeth; anterior portion shorter, bent downwards, forming in the left valve an entire, prominent sub-lunular tooth, which fits into a corresponding pit of the right valve; type, *L. costata*, Gray, from American seas. This is a remarkably distinct type of *ARCIDÆ*. I am not acquainted with any recent or fossil species exactly corresponding to it, but the palæozoic *Cardiola* shows externally a great resemblance to it.

13. *Isoarca*, Münst., 1842, (Beiträge z. Petrefacten-Kunde, &c., 6tes Heft, 1843, p. 81). Shell ovate, elongated, inequilateral, ventricose, beaks tumescent, sub-anterior, strongly incurved; ligamental hinge area wanting, represented only by a narrow groove extending from the beaks posteriorly: hinge line long, nearly straight, or slightly arched, provided in its entire length with numerous, short,

sub-equal transverse or slightly oblique teeth; surface smooth, or finely radiately striated; type, *I. decussata*, Münst., l. cit., pl. iv, fig. 14. The species of *Isoarca* are from jurassic and cretaceous deposits. Their peculiar, mostly decussated surface greatly resembles that of many *Barbatia*, but the structure of the shell itself appears to be somewhat different from that of other *ARCINÆ*, being more solid and pearly. Probably *Isoarca* will better be classed in the family *NUCULIDÆ* near the problematic genus *Otenodonta* of Salter.

14. *Argina*, Gray, 1842. Shell sub-cordate, inflated, sub-equivalve, inequilateral, beaks somewhat anterior, radiately ribbed; ligamental hinge area very narrow, hinge line slightly elongated and curved, divided by an indentation under the beaks into unequal portions, both being provided with numerous sub-equal cross denticulations, those on the anterior portion being fewer and irregularly crowded; type, *A. pexata*. The species are few, and from the American seas.

15. *Senilia*, Gray, 1847. Shell sub-cordate, tumid, inequilateral, posteriorly somewhat produced and attenuated, radiately costated, covered with an olivaceous epidermis; ligamental hinge area broad, with angularly bent striæ; hinge line nearly straight, with numerous rather large sub-equal cross-teeth, internal edge below the umbones emarginated; type, *S. senilis*, Linn., from brackish waters of West Africa. It is the only species as yet known, and may be considered as the brackish water representant of *Anomalocardia*.

16. *Anomalocardia*, Klein, 1753, (Tentamen Ostr., p. 141, *Anadara*, Gray, 1847). Shell sub-quadrangular or trapezoid, sub-equivalve, sub-equilateral, solid, radiately ribbed; ligamental hinge area large, angularly striated; hinge line straight, with numerous sub-equal cross-teeth, somewhat oblique towards the ends; type, *A. antiquata*, Linn.

16a. *Scapharca*, Gray, 1847. This has been proposed for a number of inequivalve species, like *Arca inaequalvis*, Brug., but this character is not exclusively common to the species referred to that genus by H. and A. Adams; several species of *Anomalocardia*, as, for instance, *A. granosa*, Linn., and others may often be seen inequivalve. However, though the form of these shells is quite the same as that of *Anomalocardia*, those of *Scapharca* are always of a thinner structure, with internally hollowed out ribs, somewhat inequilateral, and the ligamental area is mostly narrow. Only on this account *Scapharca* may be retained as a sub-genus of *Anomalocardia*, though in determining fossil species the division is of no great importance.

Fossil species of *Anomalocardia* occur from the Trias upwards, but until in the miocene time they are nowhere very numerous.

16b. *Nemoarca*, Conrad, 1869? (Am. Journ. Conch., V, p. 97). Shell elongately trapezoidal, sub-equilateral, tumid, radiately ribbed; ligamental area narrow; hinge line straight, with small transverse teeth; type, *N. cretacea*, Con. (l. cit., pl. 9, fig. 21). I do not know the distinction of this newly proposed genus from the elongated forms of *Scapharca*, as, for instance, *Scapharca formosa*, Sow.

17. *Barbatia*, Gray, 1840. Shell oblong, moderately tumid, radiately striated and covered with a hairy epidermis; ligamental hinge area narrow; hinge line slightly curved, with the ends somewhat dilated and provided with numerous oblique teeth, increasing in size on both sides; sometimes the median teeth become obsolete; type, *B. barbata*, Linn.

The forms of *Barbatia* are somewhat variable. The typical ones have the ventral side provided with only a very small gape in the anterior region. Others have the ventral margins more or less insinuated, the gape being enlarged, and the anterior part of the shell becomes narrow and produced. To the latter type belongs the recent *A. velata*. Both forms pass insensibly one into the other through such species as *Bar. fusca*, Brug., which is extremely variable, almost more so than *Bar. velata*, but in all species the ends of the hinge line are peculiarly flattened.

17a. *Cucullæarca*, Con., 1865(?), (Am. Journ. Conch., I, p. 11). This has been proposed for a few eocene species of North America, *Byssoarca lima*, Con., (Journ. Acad. N. Sc., Phil., 2nd ser., i, p. 125, pl. 13, fig. 23,) being considered as the type. This, as well as another species, *B. Mississippensis* of the same author, do not appear to me to exhibit any essential differences from *Barbatia*, particularly of the *B. velata* type. Both are somewhat sinuated in front, radiately striated, and the hinge has oblique teeth, increasing in size towards the ends of the hinge line. Whether the genus possesses any other peculiarities, distinct from those of *Barbatia*, cannot be concluded from the description of the two species, for I have not come across Mr. Conrad's detailed characteristic of the genus.

17b. *Acar*, Gray, 1851(?). This should include the somewhat more tumid, cancellated, and along the posterior slope carinated species; they are mostly of small size, as *Bar. divaricata* and *pusilla* of Sowerby; it forms a convenient section of *Barbatia*.

17c. For *Arca alternata* of Reeve, Gray proposed the name *Calliarca* (or *Calloarca*), the hinder slope being strongly carinated and both ends strongly ribbed. It is scarcely necessary to separate this into a distinct sub-genus, for there are numerous intermediate cancellated forms which connect *Barbatia* with true *Arca* and *Litharca*.

17d. *Striarca* has been proposed by Mr. Conrad for the miocene *Arca centenaria*, Say. The shell is oblong, with a depression running from the beak to the ventral margin, which is somewhat insinuated, no doubt corresponding to a small gape; the surface is radiately striated; the ligamental area and hinge-teeth are quite similar to those of *Barbatia*, from which the form should not, I believe, be generically separated (*vide* Conrad's mioc. shells, 1838, p. 55, pl. 29, fig. 4).

17e. *Litharca*, Gray, 1840. This has been proposed for the peculiar recent *Arca lithodomus*, Sow., a shell which is very peculiarly wedge-shaped, elongated, the anterior portion being longer, narrowly rounded in front; the posterior is shorter and very obliquely truncate; the ligamental area is of moderate width; the hinge line straight in front and somewhat bent down posteriorly. The sub-genus seems sufficiently distinct from other allied forms.

Species of *Barbatia* are very numerous through all the sedimentary formations; their number appears to increase gradually up to the present time.

18. *Arca*, Linn., 1799, (*Navicula*, *Cibota*, and *Byssoarca*, auctorum). Shell elongately sub-quadrangular, tumid, inequilateral, the anterior portion being shorter and ventrally more or less distinctly gaping; beaks distant, the ligamental hinge area being large and angularly striated; hinge line perfectly straight, with numerous sub-equal transverse teeth extending over the entire length; type, *A. Noë*, Linn.

Species of *Arca*, as restricted, occur from the silurian through all the successive formations up to the present time. The palæozoic species have often been described under Swainson's name *Byssoarca*, being a synonym of Browne's *Cibota*, under which latter some jurassic and cretaceous species have also been described. The tertiary species of *Arca* appear to be more numerous than the recent ones.

LIST OF CRETACEOUS SPECIES.

a. AXINÆINÆ.

The cretaceous species of this sub-family belong to the genera *Trigonocælia*, *Limopsis*, *Nucinella*, and *Axinæa*.

1.—*Trigonocælia galeata*, Müll., sp., (*Cardium galeatum*, Müller, *Opis galeata*, d'Orbigny, et auctorum), is from the Senonien beds at Aachen, (*vide* Bosquet in Starings Bodem v. Nederl., ii. deel, No. 408).

Limopsis, (*vide* Pictet and Camp. in Pal. Suisse, IV^{me} ser., 3^{me} part., p. 424).

2-6.—*L. Guerangeri* and *complanata* of d'Orb., *texturata*, Salt., *calva*, Sow., *Hæninghausi*, Müll. The two first are from France, the third from the Upper Greensand of Aberdeenshire, the fourth from the Alpine Gosau, and the fifth from the Aachen deposits.

7-9.—*L. rhomboidalis*, *radiata*, and *Sacheri* were described by Alth from the upper cretaceous beds of Galicia, (*vide* Favre, Moll. foss. de Lemberg., 1869, pp. 121-123).

10-11.—*L. parvula*, Meek and Hayd., and *striato-punctata*, Ev. and Shum., are from North America (see Meek, in Smith. Misc. Coll., No. 177, 1864, p. 8).

12-13.—*L. nitens* and *Oregonensis* are quoted by Conrad from his lower-eocene beds (Smith. Misc. Coll., No. 200, 1866, p. 4).

14.—*L. transversa*, Gabb, Pal. Calif., i, p. 200, is from the Chico group of California.

Axinæa (*vide* 'Cat. de *Pectunculus* crétacés connus' by Pictet and Campiche in Pal. Suisse, IV^{me} ser., 3^{me} part., p. 426).

15-16.—*Ax. Marullensis*, Leym., and *alternata*, d'Orb.

17.—*Pectunculus concentricus*, Buvignier. The hinge of this species should be examined; the outline view given by Buvignier does not clearly indicate an *Axinæa*, and the form and ornamentation of the shell remind us rather of a *Unicardium* or *Sphæriola* (*LUCINIDÆ*), than of a species of *Axinæa*.

18-37.—*Ax. sublævis*, Sow., *umlonata*, Sow., *subconcentrica*, d'Orb., *subpulvinata*, d'Arch., *Requieniana*, d'Orb., *Renauxiana*, d'Orb., *Bourgeoisiana*, d'Orb., *Marrotiana*, d'Orb., *Norica*, Zitt., *obsoleta*, Goldf., *ventruosa*, Gein., *spinescens*, Reuss, *annulata*, Rss., *Reussi*, d'Orb., *lens*, Nilss., *reticulata* and *insculpta*, Rss., *plana*, Röm., *subdecussata*, d'Orb.

38.—*Ax. obliqua* is described by Schafhäutl in Süd-Bayern's Leth. geog., (1863, p. 158), apparently from cretaceous beds of Southern Bavaria.

39-43.—*Ax. hamula*, Mort., *Siouxensis*, Hall and M., *subventricosa*, M. and Hayd., *rotundata*, Gabb, and *subaustralis*, d'Orb., are noted by Meek from North America in Smith. Misc. Coll., No. 177, 1864, p. 8.

44-46.—*Ax. Veatchii*, *sagittata*, and *cor* are described by Gabb from California, (Pal. Calif. i, 1864, p. 197 et seq.).

47.—*Ax. Mortoni*, Conrad, from New Jersey, (Am. Journ. Conch., V, p. 44).

Eichwald (Leth. ross., xme livr., 1867, p. 576), suggests that Keyserling's *Pectunculus Petschoræ* may be a Neocomien species of *Axinæa*.

48-53.—*Nucinella glabrata*, *Axinæa subplanata*, *levicula*, *altiuscula*, *subauriculata*, and *cardioides* represent this sub-family in the cretaceous deposits of Southern India.

b. ARCINÆ.

Pictet and Campiche note the species belonging to the present sub-family under the genera *Isoarca* and *Arca* (vide Pal. Suisse, IV^{me} ser., 3^{me} part., pp. 422 and 429 et seq.); I shall, therefore, take the first genus and then the second, in which it will be necessary to point out the different generic and sub-generic forms, as distinguished by later researches, and as far as admissible from existing materials.

54-58.—*Isoarca alpina*, *globulosa*, *Agassizi*, *costata*, *obesa*,* and *supracretacea*.

59.—*Isoarca gibba* is the only species occurring in Southern India; no species is known to represent the genus in America.

Arca and allied genera (see Pictet and Camp., l. cit., p. 468).

60.—*Arca marullensis*, d'Orb., *Baudoniana*, Cott., *episcopalis*, Cott., *Aubersonensis*, P. and C., *Dubiesiensis*, P. and C., and *Dupiniana*, d'Orb., are *Barbatia*.

61.—*A. Jaccardi*, P. and C., belongs to the sub-genus *Acar*.

62-63.—*A. Essertensis* and *Humbertina*, Lorient, (Favre Res. géol. de la Savoie, &c., pl. C, figs. 16 and 17,) belong either to *Arca*, or perhaps rather to the sub-genus *Calliarca*.

64-66.—*A. sanctæ-crucis*, P. and C., *Carteroni*, d'Orb., *complanata*, P. and C., (non *A. complanata*, Chem., 1784, non *Cucul. complanata*, Sow., 1840).

67.—*A. Raulini*. Leymerie's original figure would indicate a *Barbatia*, with fine radiating striae and broadly incurved, somewhat flattened, beaks; d'Orbigny's figure, supposed to be the same species, would seem rather to represent a *Cucullæa*-like shell, somewhat of the form of a *Trigonoarca* or *Nemodon*. Either one or the other of these figures must surely be incorrect, or they represent two distinct species.

68.—*A. Neocomiensis*, d'Orb., may belong to the section called *Nemodon* by Conrad.

69.—*A. securis*, Leym., is apparently one of the elongated forms of *Scapharca*, called by Conrad *Nemoarca*.

70.—*A. exsculpta*, Koch, appears to be a *Barbatia*.

71-75.—*A. Schusteri*, Röm., *Robinaldina*, *Cornueliana*, and *consobrina* of d'Orbigny, and *Villersensis*, P. and C., are most probably *Trigonoarca*.

76-83.—*A. Moreana*, d'Orb., *Gabrielis*, Leym., *tumida*, Math. (?= *Gabrielis*, Leym.), *cor* and *Astieriana* of Matheron, *Gresslyi* and *Salvensis*, Lorient, *Varusensis*, d'Orb. The last is quite insufficiently characterized; the two first ones are probably true *Cucullææ*, and the others Pictet and Campiche suggest may all be varieties of *A. Gabrielis*; the descriptions and figures published of them are quite insufficient to enable an opinion to be formed as to the specific characters of these shells.

84.—*A. ferruginea*, (non *A. ferruginea*, Reeve, which is an *Anomalocardia*), is either a *Cucullæa*, or it belongs to the sub-genus *Grammatodon*.

* = *Isocardia Orbignyana*, Leym. = *Arca isocardiiformis*, Nyst.

85-87.—*A. Aptiensis* and *Fittoni*, P. and C., and *Austeni*, d'Orb., would appear to belong to *Trigonoarca*.

88.—*A. costellata*, Sow., agrees in the character of the hinge with *Grammatodon*. Nyst suggests that the species is identical with Sowerby's *Cucullæa carinata*.

89.—*A. Forbesi*, P. and C., is either a *Cucullæa* or a *Trigonoarca*.

90.—*A. gurgitis*, P. and R., is apparently a true *Arca*.

91-94.—*A. Hugardiana*, d'Orb., *Triboleti*, P. and C., *Favrina*, P. and R., and *Ricordeana*, Cott., are *Barbatia*.

95.—*A. carinata*, Sow. This resembles an *Arca* in shape, but as the shell is unequivalve, it more probably belongs to *Grammatodon*, or some of the sub-genera of *Cucullæa*.

96-102.—*A. Campichiana*, P. and R., *Cottaldina*, d'Orb., *nana*, Leym., *subnana*, P. and R., *Hebertiana*, Cott., *bipartita*, P. and R., (non *bipartita*, Röm., 1836,) and *valdensis*, P. and C., appear to belong to *Trigonoarca*.

103.—*A. glabra*, Park., (*fibrosa* apud d'Orbigny), is a *Cucullæa*.

104.—*A. obesa*, P. and R., (non *A. obesa*, Sow., 1833), probably a *Trigonoarca*.

105.—*A. rotundata*, Sow., (= *A. rotundita*, Nyst; non *Cucul. rotundata*, Röm., 1836, et 1837 = *A. dulmanensis*, Nyst), is a *Barbatia*.

106.—*A. formosa*, Sow., (= *A. venusta*, Nyst), apparently a *Trigonoarca*.

107.—*A. elongata*, Brown, (non *Cuc. elongata*, Sow.), a *Macrodon*.

108-109.—*A. pholadiformis* and *elongatula*, Nyst, 1848 (= *Sarthacensis*, d'Orb., 1850 = *elegans*, d'Orb., 1844, non *eadem* auctorum) belong to *Arca*.

110-111.—*A. Galliennei* and *Vendinensis*, d'Orb., are *Barbatia*.

112.—*A. Albertina*, d'Orb., apparently a *Trigonoarca*.

113.—*A. Cenomanensis*, d'Orb.; this would appear to be a true *Cucullæa*.

114.—*A. Tailburgensis*, d'Orb., is a *Trigonoarca*.

115.—*A. inscripta*, d'Arch., a *Barbatia*.

116.—*A. subacuta*, Sow., apparently an *Anomalocardia*.

117.—*A. echinata*, d'Orb., is one of the forms intermediate between *Barbatia* and *Arca*.

118.—*A. subdinensis*, d'Orb., strongly resembles in form Deshayes' *Cucullaria*.

119.—*A. serrata*, d'Orb., a true *Arca*.

120-125.—*A. Guerangeri*, *Moutoniana*, *Mailleana*, *Marceana*, *Passyana*, and *Ligeriensis* of d'Orbigny all belong to *Trigonoarca*.

126.—*A. Renauxiana*, Math., is a true *Arca*.

127-128.—*A. Raspailli*, d'Orb., *Requieniana*, Math., are *Barbatia* of the type of Conrad's *Cucullæarca*; they have the general form and the posterior flattening of the hinge line of *Barbatia*, and the teeth do not appear to me to be more elongated than in large specimens of the recent *Bar. velata*; I believe, therefore, that there is not sufficient ground for the constitution of a distinct sub-genus.

129.—*A. Dufrenoyi*, Haime, a true *Arca*.

130-134.—*A. semisulcata*, Math., *Noueliana*, *Beaumontii*, *Matheroniana* of d'Orbigny, *Dumortieri*, Haime, belong to *Trigonoarca*.

135.—*A. affinis*, Duj., very insufficiently figured; the species may belong to *Arca* or *Barbatia*.

136-137.—*A. nereis* and *expansa*, Nyst, 1848, (*alata*, Math., 1842, *subalata*, d'Orb., 1850), are probably *Barbatia*.

138-147.—*A. Archiaciana* and *sagittata*, d'Orb., *lavis*, *Marticensis*, and *Galloprovincialis* of Matheron, *Santonensis*, d'Orb., *Orbignyana*,* Math., *Royana* and *cretacea*, d'Orb., all appear to belong to *Trigonoarca*.

* Nyst suggests that this species is probably tertiary, but does not give the authority for this supposition.

148-151.—*A. corbaria*, *supracretacea*, *Merope*, and *Gravesii* of d'Orbigny are merely known by name.

152.—*A. Olisiponensis*, Sharpe, probably a *Trigonoarca*.

153-154.—*A. inclinata*, Rss., and *A. Reussiana*, Nyst, (*angulata*, Rss., *A. subangulata*, d'Orb.), are true *Arcae*.

155.—*A. isopleura*, Rss., has an appearance of an *Arca*, but figure and description are insufficient.

156.—*A. Geinitzii*, Rss., is a *Barbatia*, (Favre, Moll. foss. de Lemberg, 1869, p. 125).

157.—*A. furcifera*, Münster, apparently an *Arca*.

158-162.—*A. propinqua*, *striatula*, *bicarinata*, of Reuss, *tenuistriata* (Favre, Moll. foss. de Lemberg, 1869, p. 124,) and *radiata* of Münster belong to *Barbatia*.

163.—*A. arcacea*, Rss., a very small, but typical *Trigonoarca*.

164.—*A. Gosaviensis*, (*Cucullæa*), Zittel, is a very elongated *Trigonoarca*.

165-166.—*A. Schwabenaui*, *inæquidentata*, and *Lommeli*, Zittel, are *Barbatia*.

167-168.—*A. trigonula*, Zittel, and most likely also *striatissima*, Hag., belong to *Arca*.

169.—*A. trapezoidea*, Gein., is an *Anomalocardia*.

170-171.—*A. undulata* and *pygmæa*, Rss., may be peculiar forms of *Trigonoarca*, or perhaps of *Scapharca*.

172-173.—*A. bifida* and *dictyophora*, Rss., resemble *Arca* in external form.

174.—*A. curta*, Nyst, 1848 (= *A. Reussi*, d'Orb., 1850 = *truncata*, Rss., non Sow.), possibly a *Grammatodon*.

175.—*A. Octavia*, d'Orb., an *Anomalocardia*.

176-179.—*A. (Cucullæa) Austriaca* and *bifasciata*, Zittel, *A. carinifera*, and *globulosa*, Gümbel, (Bay. Alp., 1861, p. 570, non *A. globulosa*, Desh., 1824).

180-181.—*A. Leopoliensis* and *Galiciensis*, Alth., (Favre, M. foss. de Lembg., 1869, pp. 126 and 127,) belong to *Trigonoarca*.

182.—*A. granulato-radiata*, Alth., (Favre, M. foss. de Lembg., 1869, p. 128,) apparently an *Arca*.

183-189.—*A. rhombea*, Nilss., (non idem Born, ? = *glabra*, Sow.), *subglabra*, d'Orb., (*glabra* apud Goldfuss, pl. 124, fig. 1 c, sed non *glabra* apud Rss. = *glabra*, Park. et Sow. = *Cuc. carinata*, Sow.), *ovalis*, Nilss., *concentrica* of Römer, *exaltata*, Nilss., *Chimiensis*, Gümb., and *crassitesta*, Zitt., are species of *Trigonoarca*.

190-191.—*A. tricarinata*, Gein., *cuneata*, Röm., are quite uncertain.

192.—*A. decussata*, Sow., is a *Cucullæa*.

193-194.—*A. (Cucul.) Goldfussi* and *texta* of Römer apud Müller are considered by the latter author to be the same as two forms from the Aachen cretaceous deposits, which probably do not differ from d'Orbigny's *subglabra*, this being closely allied to our Indian *Trigonoarca Gamana*.

195-196.—*A. orbicularis* and *Roemeri*, Gein., are uncertain; they probably both belong to *Cucullæa*; the former Reuss states to be the same as his *Axinæa insculpta*, which is not improbable.

197.—*A. securiformis*,* Kner., (Denksch. Akad., Wien, iii, p. 314, and Favre, M. foss. de Lemberg, 1869, p. 129), an *Arca*-like shell, but as the ventral margin does not show a tendency to insinuation, it may rather be an elongated *Cucullæa*.

198-201.—*Arca æquilateralis*, (non *Cuc. æquilateralis*, Meek), *caudata*, *exornata*, and *Omalii*, Briart et Cornet, (Foss. de la meule de Braiquegnies, p. 57 et seq., Mém. Cour. Acad. Belgique, xxxiv, 1870,) partially belong to *Cucullæa*, partially to *Trigonoarca*.

202.—*A. Aquisgranensis*, Müller, (Suppl. zur Monog. Pet. Aachener Kreidef., 1859, p. 10,) is either a *Barbatia* or an *Arca*.

* Non *Arca securiformis* apud Nyst, which is a *Dolabra*.

203.—*A. Kaltenbachii*, Müll. (*ibid.*, p. 29,) apparently a *Barbatia*.

204.—*A. sinuosa*, Guéranger, (Album pal. de la Sarthe, 1867, pl. xxi, fig. 7,) is most probably a *Barbatia*, but the figure is very indistinct.

205-206.—*A. tegulata* and *plana*, Guéranger, (*ibid.*, pl. xxi, figs. 14 and 16,) both belong to *Barbatia*, and the same would appear to be the case with the next species.

207.—*A. albæ-cretæ*, Tate, (Quart. Journ. Geol. Soc., Lond., xxi, p. 40).

208-210.—*A. sablieri*, *bicarinata*, (non *bicarinata*, Reuss), and *dilatata* (non *C. dilatata*, d'Orb.), are described by Coquand in his Mon. de l' étage Aptien, 1866, pp. 137 et seq. All three externally resemble *Trigonoarca*.

211.—*A. Cymodoce*, Coquand, (*ibid.*, p. 140,) is a true *Arca*.

212-218.—*Cucullæa Fischeri*,* d'Orb., sp., *C. signata*, Rouill., *C. vogulica*, Eichw., *Fischeriana*, Nyst, 1848, (*elegans*, Fischer = *C. subelegans*, d'Orb., 1850), *C. compressiuscula*, Rouill., *C. Schourowskii*, Rouill., and *angularis*, Eichw., are described by Eichwald from cretaceous beds of European and Asiatic Russia (Leth. ross., xme livr., 1867, pp. 559 et seq.). Besides these the author quotes several other previously enumerated species and identifies with them some others which Trautschold, d'Orbigny, and others have described from jurassic beds. Whether Eichwald's determination of the geological horizons is more correct than that of other authors who have investigated the same subject is, I believe, still an undecided question.

219-225.—*Arca Delettrei*, *Tevesthensis*, *Favrei*, (non *Favrina*, P. and R.), *hiempsalis*, *parallela* (non *Cucullæa parallela*, Con.), *Trigeri*, and *Refanensis* are described by Coquand from Algiers (Const., 1862, pp. 211 et seq.). Of none of the species have the hinge-teeth been examined; the first five have quite the general form of *Trigonoarca*, the sixth most likely belongs to the same genus, but the seventh is altogether doubtful.

226-227.—*A. Uzambaniensis* et *Natalensis*, Baily, (Quart. Journ. Geol. Soc., Lond., xi, pp. 460,) are from South Africa. The second is a *Cucullæa*; the first either belongs to the same genus or to *Trigonoarca*.

228.—*Cucullæa cancellata* (non *Cuc. eadem*, Phill., or Rouillier,) was described from South Africa by Krauss from supposed cretaceous rocks (Nov. act. Ac. Leop.-Car., xiv, pt ii, p. 452). The specimen is imperfect, but appears to represent a peculiar type of *Cucullæa*. It is not an *Arca*, and it remains yet to be seen whether it is a *Cucullæa*, and therefore Tate's suggestion of changing the specific name to "*Kraussi*" is altogether premature (*vide* Quart. Journ. Geol. Soc., Lond., 1867, xxiii, p. 161).

As the geological horizons in the secondary deposits of South Africa do not appear to me sufficiently settled as yet, I may here at least quote the two other species of *ARCINÆ* described from those regions; *Cuc. (Macrodon) Atherstonei*, Sharpe, and *Arca* (? *Cucull.*) *Jonesi*, Tate, (*ibidem*, p. 161).

229-232.—From South America *A. subrostellata*, *brevis*, *Tocaymensis*, d'Orb., and *perobliqua*, Buch, are on record. The first species may be a *Barbatia*, the second is probably a *Cucullæa*, the third an *Arca*, and the fourth would rather appear to be a *Trigonia*, than any of the genera of *ARCINÆ*.

233.—In Paléon. Am. Merid., p. 89, d'Orbigny describes a *Cucullæa dilatata*, but in the Prodrôme he quotes it as identical with the European *Gabrielis*. The former is, however, to all appearance a more inequilateral and less high shell, than the European type of the latter species.

234-235.—*A. Sillimaniana* and *Cuc. dubia*, Lea, (Trans. Am. Phil. Soc., vii, p. 259, pl. x, figs. 16-17), are stated to be from cretaceous rocks in Cuba; they are casts, perfectly insufficient for specific determination.

236-246.—*Cucullæa* ? *æquilateralis*, Meek, *antrosa*, Mort., *exigua*, M. and Hayd., (*Trigonoarca*) *Maconensis*, Conr., *C. Nebrascensis*, Owen, *Shumardi*, M. and H., *terminalis*, Con., *tippana*, Con., *transversalis*, Gabb, (non *A. transversalis*, Nyst, 1848), *ungula*, Tuomey, and *vulgaris*,

* Non *A. Fischeriana*, Nyst 1848.

Mort., are recorded from North America by Meek (Smith. Misc. Coll., No. 177, 1864, p. 8). Which of these species belong to *Trigonoarca* (and I suppose most of them) remains yet to be ascertained.

247-257.—*Arca altirostra*, Gabb, *Proutiana*, Shum., *quindecemradiata*, Gabb, *Saffordi*, Gabb, *subelongata*, Con., (non *A. subelongata*, Nyst, 1848), *sulcatina*, Evans and Shum., *uniopsis*, Con., *Vancouverensis*, Meek, (*Cibota*) *lineata*, Con., (non *A. lineata*, Goldf.), (*Cib.*), *multiradiata*, Gabb, and (*Cib.*) *rostellata*, Mort., (Meek, *ibidem*). In this list the distinction between *Barbatia* and *Arca* does not appear to have been carried out.

258-259.—*A. Alabamensis*, d'Orb., (Prod., ii, 245), *A. Eufalensis*, Gabb, (Journ. Ac. Ph., 2nd ser., iv, 398; see also *Nemodon*, p. 336).

260.—*Nemoarca cretacea*, Con., (see p. 339).

261.—*Nemodon Eufalensis*, Conrad, (see p. 336).

262-268.—*Arca Breweriana*, *gravida*, *decurtata*, and *Hornii*, *Barbatia Morsei*, *Cucullæa Mathewsonii*, and *truncata*, (non *A. truncata*, Sow., 1833, non *A. truncata*, Rss., 1843 = *A. curta*, Nyst, 1848,) are described from California by Gabb in Pal. Calif. i, pp. 193 et seq.; besides these two others already mentioned.

269.—*Cucullæa inermis*, Gabb, (Pal. Calif., ii, p. 271,) is from Mexico.

270-273.—*Latiarca transversa*, Rog., *L. ononcheila*, Rog., *L. gigantea*, Con., and *Anomalocardia devincta* are noticed by Conrad from his lower eocene (? cretaceous) beds (Smith. Misc. Coll., No. 200, 1866, p. 4; see also p. 338).

274.—*Trigonoarca passa*, Con., (Am. Journ. Conch., V, p. 43).

275.—*Trig. cuneiformis*, Con., (*ibid.*, V, p. 98).

Römer notes (Kreidebild. von Texas, p. 53,) two not specifically determined forms of *Arca* and two of *Cucullæa* from the cretaceous beds of Texas.

Conrad described in Lynch's Exped. the following four species from Palæstine, which Fraas (Würtemb. Nat. Jahresh., xxiii, p. 233,) partially identifies with known species:—

276-279.—*A. parallela*, Con., (= *securis*, Leym.); *A. lintea*, Con., (= *cenomaniensis*, d'Orb.); *A. sub-rotundata* and *fabiformis*, Con. Farther, Fraas says that Conrad's supposed jurassic *A. brevifrons* is remarkably similar to *A. Passyana*, d'Orb. A great many other supposed jurassic species Fraas rejects altogether, the species having been based upon worthless casts which cannot be again recognised, and there also seems, he says, very little proof existing in favor of the jurassic age of those species. It is always difficult to determine species satisfactorily from cast specimens, but especially in cases of such thick shells, as the *ARCINÆ* usually possess, the determination of species based upon casts becomes an impossibility.

The following species of the sub-family *ARCINÆ** have been found in our South Indian cretaceous deposits:

280-293.—*Cucullæa æquata*; *Macrodon* (? *Grammatodon*) *Japeticum*, *Macr.* (? *Gramm.*) *disparile*; *Trigonoarca Telugensis*, *abrupta*, *Trichinopolitensis*, *Gamana*, *Brahminica* and *Galdrina*; *Scapharca Ponticeriana*, ? *Scaph. Clellandi*; *Barbatia decora*, *B. diatreta*; *Arca filistriata*. They are represented almost equally in all the three sub-divisions of the cretaceous deposits.

At the end of their review of cretaceous species of *Arca*, Pictet and Campiche, (loc. cit., p. 483,) give a list of names which, they say, should be excluded from the genus "*Arca*," as referring to perfectly unknown species. These names are to a great extent merely the altered appellations of various species noted in the preceding list; they were introduced by Nyst, but it would have been much better if Nyst had reserved his corrections for a little time, and had studied the various generic forms of *ARCINÆ*, instead of adhering to Linné's genus "*Arca*" and simply cataloguing the synonyms of the species described. In his desire to preserve the unity of Linné's genus he even goes so far as to regard *Pleurophorus* of King as identical with *Arca*!

* Excepting *Isoarca gibba* already noticed.

NUCINELLA, *Wood*, 1850, (see p. 334).1. NUCINELLA GLABRATA, *Stoliczka*, Pl. XVII, Fig. 21, and Pl. XLIX, Figs. 7-8.

N. testa minima, oblique ovata, tumidula, glabra et polita, ad marginem inferiorem rotundata, postice sub-truncata, umbonibus prominulis, obtusis, terminationibus marginis cardinalis vix conspicuis. Cardo dentibus circiter 6-7, parvis, in serie non interrupta et leviter curvata dispositis, instructus, dente laterali antico crasso, remoto, in valva dextra simplici, in v. sinistra duplici.

Height of shell (see Pl. XLIX, Fig. 7,) about equal to its length.

Thickness of shell equal to half the length.

This is the first cretaceous species of *Nucinella* on record. It is closely allied to the tertiary *N. ovalis*, and only distinguished by a slightly narrower ovate form and posteriorly less prominent hinge margin. The lateral tooth is in both valves very distinct and remote from the cardinals, as in the eocene *miliaris*; it is single in the right and double in the left valve; the cardinal teeth are about seven in number, small and tuberculiform.

Locality.—Moraviatoor, in dark earthy limestone; apparently rare.

Formation.—Ootatoor group.

AXINÆA, *Poli*, 1791, (see p. 334).1. AXINÆA SUBPLANATA, *Stoliczka*, Pl. XVII, Figs. 28-30, and Pl. XLIX, Fig. 10.

Ax. testa latiuscule ovata, fere æquilaterali, antice uniforme convexa, postice ad medium sub-angulata, vix longiore, umbonibus acutis, tumescentibus instructa, ad margines compressiuscula, sub-lævigata, sulcis incrementi nonnullis profundis prope marginem distinctioribus et striis radiantibus sub-obsoletis tecta; area ligamentali parva, angulatim striata, valde declivi; cardo dentibus 9-11 in utroque latere descendentes et in medio nonnullis minoribus obliquis instructus; margine interno crasse denticulato.*

Height of shell	:	its length	...	...	...	0.90 - 0.96
Thickness	„	:	„	...	...	0.35 - 0.40

The form of this species slightly varies, sometimes it is nearly orbicular and strongly compressed (fig. 29), or it is somewhat more elongated and inflated (fig. 28), but the valves are always conspicuously flattened towards the margins, while the beaks are tumescent and prominent; the surface is in well preserved specimens almost smooth, but when slightly worn off, faint, radiating, and concentric striæ appear; besides this there are near the periphery generally a few deeper sulci to be observed. The ligamental area is small and very rapidly descending; the hinge-teeth numerous; the inner margin strongly denticulated, except close to the hinge-teeth; the upper half of the posterior margin is sub-truncated in

* Figs. 28 and 30 should be posteriorly near the middle slightly subangular, the margin above the angle being rather straight, that below it convex.

all specimens, and should have been better indicated in fig. 30, for which see the corrected fig. 9 on pl. xlix.

Localities.—Shillagoody and Olapaudy, in conglomeratic sandstone.

Formation.—Arrialoore group.

2. AXINÆA LEVICULA, *Stoliczka*, Pl. XLIX, Figs. 5-6.

Ax. testa sub-orbiculata, æquilaterali, crassiuscula, umbonibus parvis, tumidis, valde approximatis et area ligamentali brevi instructa, postice ad medium vix sub-angulata; valvis convexis, sub-levigatis, striis minutissimis et confertissimis concentricis et nonnullis sulcis incrementi profundioribus, prope peripheriam sitis, præditis, superficie paulo erosa striis seu lineis impressis, angustis, radiantibus notata; margine interno denticulato.

Height of shell about equal to its length.

Thickness of shell : its length 0.66

This species differs from *A. subplanata* by its considerably more rounded form and the greater convexity of the valves. In the perfect shell the surface is quite smooth, but when slightly worn off the usual radiating lines appear. The ligamental area is very small and very oblique, so that the beaks come very close to each other.

Localities.—Arrialoore, in soft whitish sandstone; *Pondicherry*, in a greenish grey compact sandstone; rare.

Formation.—Arrialoore group.

3. AXINÆA ALTIUSCULA, *Stoliczka*, Pl. XLIX, Fig. 9.

Ax. testa sub-rotundata, fere æquilaterali, paululum obliqua, altiore quam longa, valva sinistra moderate convexa, crassa, sub-levigata, sulcis incrementi precipue prope peripheriam distinctis, paulo irregulariter continuis, prædita; area ligamentali latiuscula, valde declivi; dentibus cardinis crassis, 9 in utroque latere, elongatis, mediis multo minoribus; margine interno denticulato.

Height of left valve : its length 1.08

Thickness „ : „ 0.20

The somewhat greater height in proportion to length, the greater convexity of the valves and solid structure readily distinguish this species from *subplanata*, and the first difference also holds good in a comparison with *Ax. levicula*. It is closely allied to Zittel's *Ax. norica* from the Gosau, but less convex, apparently a little more oblique, and without the distinct and coarse radiating striation which characterizes the European species.

Localities.—Ootacoil and Ninnyoor, in a pinkish limestone (evidently coral-reef-limestone).

Formation.—Arrialoore group.

4. *AXINÆA SUBAURICULATA*, Forbes, Pl. XVII, Figs. 31-32.1846. *Pectunculus subauriculatus*, Forb., Trans. Geol. Soc., Lond., vii, p. 150, pl. xvii, fig. 13;—*idem* auctorum.

Ax. testa sub-rotundata, æquilaterali, paululum obliqua, crassa, postice ad marginem sub-truncata, infra medium sub-angulata, tumida, radiatim costulata, costulis confertis; area parva, valde declivi; cardine dentibus elongatis, 9-10 in utroque latere, et circiter decem intermediis, minoribus, instructo; margine interno denticulato.

Height of shell	:	its length	...	...	...	...	1.04
Thickness	„	:	„	...	...	...	0.68

Distinguished from the next species by its rounder shape, smaller and more precipitous area, and closer radiating ribbing.

Locality.—Kunnamore, in grey sandstone.

Formation.—Arriallor group.

5. *AXINÆA CARDIOIDES*, d'Orbigny, Pl. XVII, Fig. 33, Pl. L, Fig. 8.1847. *Area cardioides*, d'Orb., Voy. Astrolabe, Paléont., pl. iv, figs. 35-36;—*eadem* auctorum.

Ax. testa sub-rotundata, paulo longiore quam alta, tumida, sub-æquilaterali, obliqua, postice plus minusve distincter producta et sub-truncata, radiatim costulata, costulis in declivitate antica et postica fere obsoletis, in medio sulcis aut æquidistantibus aut angustioribus separatim, nonnunquam sub-granosis, ornata; umbonibus prominentibus, incurvis; area ligamentali magna, moderate declivi; cardine crasse et pliciforme multidentato.

Height of shell	:	its length	...	...	...	0.86 - 0.90
Thickness	„	:	„	...	...	0.76 - 0.78

There are slight variations to be observed in the form and ornamentation of this species. D'Orbigny figured a comparatively very inequilateral and oblique specimen from Pondicherry; we have exactly similar specimens from Ootatoor and Odium, (see pl. l, fig. 8). Another specimen from the same locality and one from Serdamungalum out of a conglomeratic calcareous rock are somewhat less produced posteriorly, and the radiating ribs are a little more distant from each other, than is generally seen in Ootatoor specimens, but there is no appreciable specific distinction between the two forms. Although the shell is somewhat oblique, the distribution of the hinge-teeth clearly shows that it belongs to *Axinæa*.

Localities.—Pondicherry, Ootatoor, Odium, and south-east of Serdamungalum.

Formations.—Ootatoor and Trichinopoly groups.

ISOARCA, Münster, 1842, (see p. 338).

1. *ISOARCA GIBBA*, Stoliczka, Pl. VIII, Fig. 3, and Pl. XVII, Fig. 36.

I. testa trapezoidali, valde gibbosa, tenui, sub-inæquilaterali, antice rotundata, postice paulo producta, oblique convexa truncata; umbonibus valde incurvis, approximatis; superficie minute reticulata vel decussata, striis filiformibus, concentricis,

confertissimis et alteris minutioribus radiantibus ornata; area cardinali leviter curvata, multidentata.

Only the two figured specimens have been found of this species; the one (on pl. 8) is large, somewhat irregularly gibbose, and has portions of the shell preserved; the other is a smaller, but complete cast of the left valve. The fine reticulated surface of the shell is very peculiar and mostly characteristic of this genus, as already noticed.

Localities.—East of Parally, in a brownish earthy limestone; north of Odium, in a similar but still more earthy rock.

Formation.—Ootatoor group.

CUCULLÆA, Lamarck, 1801, (see p. 337).

1. (?) CUCULLÆA ÆQUATA, Stoliczka, Pl. XVII, Fig. 34.

C. testa rotundate sub-tetragona, moderate convexa, æquilaterali, sub-lævigata, antice ac postice minute radiatim striata, solidula; cardo in utroque latere dentibus tribus sub-parallelis, paulo irregularibus, instructus.

The only valve yet found has been figured; the beak and the ligamental area are imperfect, and they must have been very small. The hinge shows about three sub-horizontal ribs on either side, becoming somewhat irregularly connected near the middle, but, on the whole, resembling those of recent and fossil species of *Cucullæa*; however, as the ligamental area is not preserved, I do not regard the generic determination as sufficiently certain, for the shell may represent a new generic type. It is to be hoped that the discovery of better specimens will clear up these doubtful points. The form of the shell is so characteristic that it could not easily be mistaken for any other genus, excepting *Axinæa*.

Locality.—Ninnyoor, in a yellowish sandy limestone.

Formation.—Arrialoor group.

MACRODON, Lycett, 1845, (see p. 336).

1. MACRODON (? GRAMMATODON) JAPETICUM, Forbes, Pl. XVIII, Figs. 6-11.

1846. *Arca japetica*, Forbes, Trans. Geol. Soc., Lond., vii, p. 148, pl. xvi, fig. 2—*eadem* auctorum (non = *A. disparilis*, d'Orb.).

Mac. testa elongata, pertumida, crassissima, obliqua, antice brevior et sub-rotundata, postice producta, oblique truncata, regione ab apice ad terminationem postero-inferiorem extensa sub-angulata seu obtuse carinata; superficie striis crispiculatis et sulcis incrementi tenuioribus et fortioribus tecta, medio radiatim costata: costis in valva dextra conspicuiter distantioribus interdumque minoribus alternantibus, in valva sinistra magis approximatis; omninis in terminatione antica et postice sub-obsoletis; declivitate postica minute striata, sub-excavata, ad medium costula tenui ab umbone postice extensa, prope peripheriam obsoleta, divisa, striis in speciminibus

No near relations to Grammatodon.

adultis nonnunquam etiam obsoletis; area ligamentali latissima, angulatim multi-sulcata; umbonibus distantibus, incurvis, sub-sulcatis. Cardo in utroque latere plicis 3-4 elongatis, supra et infra denticulatis, instructus, anticis primo paulo curvatis, deinde fere horizontaliter extensis, posticis parallelis; dentibus medianis paucis, parvis, obliquis, irregularibus; impressione musculari postica in lamina erecta, elongata, sita; margine interno indistincter plicose denticulato.

Average height of shell	:	its length	...	...	...	about 0.73
Thickness	"	"	...	...	...	" 0.70
Length of largest specimen	...	...	...	...	...	80 m. m.

The elongated oblique form and great convexity of the valves with the very wide ligamental area are particularly characteristic of this species. The two valves are only slightly unequal, but the difference in the ornamentation is generally very apparent. On the left valve the radiating ribs are distant, generally separated by interspaces wider than the thickness of the ribs and sometimes marked with intervening thinner ribs; on the right valve the ribs are all about equally strong, but they are placed much closer together. On the posterior declivity there only exists a fine radiating striation, and even this becomes partially obsolete in large specimens. The hinge is peculiar and slightly different from that of typical *Macrodon*, but, as already noticed, (p. 336), I am not certain whether Meek's name *Grammatodon* is sub-generically applicable to these forms. The hinge-teeth in *Macrodon* are anteriorly very short, posteriorly very elongated. In the present species the teeth, or rather hinge-ribs, are sub-equal on the two sides, the anterior are first oblique, then bent outward, and prolonged almost horizontally, or slightly sloping downwards, the posterior hinge-ribs are parallel throughout, and very nearly quite straight, as in *Cucullæa*; in the middle there are a few short somewhat irregular teeth; all the teeth and hinge-ribs are finely denticulated above and below. The posterior muscular impression is situated on a raised, elongated plate.

Localities.—Karapady, Arrialoor, Comarapolliam, Ootacoil, &c., in whitish sandstone; very common.

Formation.—Arrialoor group.

2. MACRODON (? GRAMMATODON) DISPARILE, d'Orbigny, Pl. XX, Figs. 6-7.

1847. *Arca disparilis*, d'Orb., Voy. Astrolabe, Paléont., pl. v, figs. 37-38.

Mac. testa elongate sub-quadrangulari, valde inflata, antice sub-rotundata, postice oblique truncata, ab umbonibus ad terminationem postero-inferiorem obtuse angulata aut sub-carinata; umbonibus latis, prominentibus, incurvis, medio obsolete uni-sulcatis; superficie radiatim costata et striis decussantibus confertissimis, precipue in speciminibus junioribus distinctis, tecta, costis in valva sinistra paulo distantioribus quam in valva dextra; declivitate postica lata, paulo concaviuscula et radiatim confertim striata; area ligamentali lata, angulatim crasse lamellose striata. Cardo plicis dentiformibus 3-4 anticis, angulatim externe recurvatis et prolongatis, mediis

+ *Altogether different from Grammatodon.*

4-5 obliquis et 5 posticis elongatis fere horizontalibus et parallelis instructus, omninis in lateribus superioribus ac inferioribus minute striolatis; margine interno antero-ventrali plicatim dentato.

Height of shell	:	its length	...	...	...	...	0.83
Thickness	„	:	„	...	...	...	0.79

This species differs by its greater height in proportion to its length, by the narrower area and more strongly bent anterior hinge-teeth, from *Mac. japeticum*; it is to all appearance the species which has been figured by d'Orbigny under the name of *Arca disparilis*, which can appropriately be retained for it. The difference in the ribbing of the two valves is similar to that noticed in the previous species, but the ribs themselves are not so strong as in that species.

Locality.—Near Alundanapooram, in a light coloured calcareous sandstone.

Formation.—Trichinopoly group.

TRIGONOARCA, Conrad, 1867, (see p. 337).

1. TRIGONOARCA TELUGENSIS, Stoliczka, Pl. XIX, Fig. 1.

Trig. testa sub-quadrangulati, moderate inflata, postice ab umbone valde carinata et ad marginem sub-oblique truncata; umbone valvæ sinistræ obtusiusculo, sulcato, breviter incurvo; superficie costulis radiantibus, striis tenuioribus concentricis decussatis, in declivitate postica sub-obsoletis, in antica sub-spinulosis ornata; area angustissima, angulatim bistriata; cardo dentibus pluribus divaricatis, exterioribus paulo longioribus, instructus.

Height of shell	nearly equal to its length.					
Thickness	„	:	its length	...	...	0.78

Only a single valve of this rare species has as yet been found, but it is characteristically different from any other cretaceous species. It is not much inflated, posteriorly strongly carinated, very broadly truncate, and possesses a very narrow ligamental area. The fine concentric striæ form on the radiating ribs little tubercles, which are almost spinulose on the anterior side of the shell. The hinge-teeth are the same as in other species of *Trigonoarca*.

Locality.—North of Alundanapooram, in a brownish highly calcareous sandstone.

Formation.—Trichinopoly group.

2. TRIGONOARCA ABRUPTA, Forbes, Pl. XIX, Figs. 4-5.

1846. *Arca abrupta*, Forbes, Trans. Geol. Soc., Lond., vii, p. 149, pl. xiv, fig. 2;—*eadem* auctorum.

Trig. testa magna, sub-trigonata, sub-æquilaterali, antice valde producta, ad marginem sub-rotundata, postice acute carinata, deinde abrupte declivi et oblique sub-truncata, umbonibus latis, prominentibus, incurvis; superficie striis, costuliformibus, radiantibus, alteris parum tenuioribus concentricis decussatis, notata; margine

interno levi; dentibus cardinalibus anticis multo longioribus magisque numerosis quam posticis.

Height of shell : its greatest length	...	...	...	0.88
Thickness „ : „ „	...	...	...	0.77
Length of the largest specimen	...	...	...	140 m. m.

The sub-æquilateral obliquely trigonal shape of the shell with its posterior very prominent ridge, from which it rapidly slopes down, is a most distinctive character of this species. The area is always very broad and angularly sulcated, but its length varies, being anteriorly more or less produced; posteriorly it is always shorter. The hinge-teeth are more elongated anteriorly than posteriorly, and in the middle they often are very small and irregular. The surface of the shell is radiately and concentrically striated, the radiating striæ are the stronger, and the concentric ones are usually intersected at moderate distances by somewhat deeper furrows. In very large specimens the striation often entirely disappears.

Locality.—Near Serdamungalum, in a brownish limestone or whitish sandstone; not common. Forbes quotes the species from Verdachellum.

Formation.—Trichinopoly group.

3. TRIGONOARCA TRICHINOPOLITENSIS, Forbes, Pl. XVIII, Figs. 12 and 14, Pl. XIX, Figs. 2, 3, Pl. XX, Figs. 2, 8, 9, 10.

1846. *Arca Trichinopolitensis*, Forb., Trans. Geol. Soc., Lond., vii, p. 150, pl. xv, fig. 16;—*eadem* auctorum.

Trig. testa elongate quadrangulæ seu trapezoidali, obliqua, moderate tumida, solidula, antice ad marginem rotundata, postice ab umbonibus valde carinata, terminatione inferiori producta, ad marginem oblique truncata, striis radiantibus et alteris decussantibus minutis, confertissimis, tectâ; area ligamentali moderate lata, profunda, angulatim crasse sulcata; cardo dentibus 5 anterioribus, et 5-6 posterioribus instructus, primis interdum fere parallelis, alteris distinctius obliquis, medianis parvulis, numerosis; margine interno levigato.

Height of shell : its length	...	...	...	0.67 - 0.82
Thickness „ : „ „	...	...	...	0.54 - 0.65

This is, as regards form, a very variable shell, some specimens being almost quadrangular and others nearly trapezoidal, but they are posteriorly always strongly ridged, considerably more produced than anteriorly, and at the margin very obliquely truncate. The striation is peculiar and always traceable, except on the posterior declivity, where the striæ often become obsolete. The area is always of moderate width, never as wide as in *T. abrupta*, and not so narrow as in *Tr. Telugensis*. The hinge-teeth also differ from both species; the anterior are somewhat bent outward and become almost horizontal and parallel among each other, approaching in position those of the two species noted as *Macrodon* (? *Grammatodon*), but the posterior teeth are regularly oblique, as in typical *Trigonoarca*.

Localities.—Anapady, Garudamungalum, Serdamungalum, Alundanapooram; mostly in calcareous sandstone.

Formation.—Trichinopoly group.

4. TRIGONOARCA GAMANA, *Forbes*, Pl. XX, Figs. 4-5, and Pl. L, Fig. 7.1846. *Arca Gamana*, *Forb.*, *Trans. Geol. Soc., Lond.*, vii, p. 148, pl. xvi, fig. 3—*eadem* auctorum.1847. *Ar. similis*, *d'Orb.*, *Voy. Astrolabe*, pl. iv, figs. 33-34.

Trig. testa oblique trapezoidea, inflata, crassa, sub-inæquivalvi, antice sensim anguste sub-rotundata, postice valde carinata et producta, declivitate postica abrupta, ad marginem oblique truncata; superficie concentrice minute striata, striis confertis, sulcis profundioribus intersectis, parte postica sæpe costulis radiantibus nonnullis sub-obsoletis notata; area ligamentali lata, crasse lamellose furcata; cardine dentibus longioribus, obliquis, 5-6 in utroque latere, in margine cardinali recto 20-26, ad medium multo brevioribus, instructo; impressione musculari postica in lamina modice elevata sita.

Height of shell	:	its length	...	...	...	0.76 - 0.80
Thickness	„	:	„	...	...	0.70 - 0.72

This species appears closely allied to *Trig. Trichinopolitensis*, differing from it by a more solid structure of the shell, which also is more inflated; it possesses a wider ligamental area, and has the anterior part conspicuously narrowed; the radiating striæ are either very faint or more often quite obsolete. Of European species Zittel's *Trigon. crassitesta* is closely allied, but apparently shorter and higher.

Localities.—Poodoor, Odium, Monglepaudy, &c., mostly in a brownish calcareous sandstone; not uncommon.

Formation.—Ootatoor group.

5. TRIGONOARCA BRAHMINICA, *Forbes*, Pl. XVIII, Fig. 13, and Pl. XX, Figs. 1 and 3.1846. *Arca brahminica*, *Forbes*, *Trans. Geol. Soc., Lond.*, vii, p. 149, pl. xvi, fig. 1—*eadem* auctorum.1847. *Arca Fontanieri*, *d'Orb.*, *Voy. Astrolabe, Paléont.*, pl. v, figs. 34-35.

Trig. testa sub-quadrangulati, inflata, antice leviter rotundata, postice plus minusve producta atque oblique truncata, area in speciminibus junioribus sub-angusta, in adultis latissima; superficie striis concentricis crassiusculis, filiformibus, confertissimis et alteris radiantibus minutissimis, medio fere omnino obsoletis, induta.

Height of shell	:	its length	...	...	...	0.74 - 0.80
Thickness	„	:	„	...	...	0.68 - 0.90

The peculiar character of this species consists in the regularity of the concentric filiform and very close striation, being quite distinct from that of any other of the Indian species. There are also some very fine radiating striæ to be noticed on the anterior and posterior side of the shell, but in the middle they become quite obsolete on the ribs, and can hardly be traced in the furrows between them. The form of the shell is very variable. Young specimens are moderately inflated, sub-quadrangular, anteriorly rather strongly compressed, and the lunula is comparatively narrow. In advanced age the shell rarely increases proportionately in

length, but it always does so in its thickness, the ligamental area becoming very broad and rather closely angularly sulcated. In this stage some of the specimens, as, for instance, the one represented in fig. 3 of pl. xx, are so remarkably like the European *Trig. Matheroniana*, d'Orb., that I do not think their identity by any means improbable, but unfortunately I have no typical specimens for comparison. The hinge-teeth of *Brahminica* are also very similar to those of *Matheroniana*. There are four or five oblique teeth on either side below the angle; the median hinge-teeth become very small towards the middle, sometimes they are nearly obsolete, the hinge-line itself being thin, and in this respect strongly differs from that of *Trig. Gamana*.

Localities.—Neighbourhood of Karapaudy, Arrialoor, Mulloor, Comarapoliam, &c., mostly in a coarse sandstone; not very common.

Formation.—Arrialoor group, of which the species appears to be equally characteristic, as is *Trichinopolitensis* of the Trichinopoly and *Gamana* of the Ootatoor group.

6. TRIGONOARCA GALDRINA, d'Orbigny, Pl. XVIII, Figs. 2—5.

1847. *Arca Galdrina*, d'Orb., Voy. Astrolabe, Paléont., pl. v, figs. 32-33—*eadem* auctorum.

Trig. elongate trapezoidali, inæquilaterali, moderate inflata, antice sub-rotundata, postice carinata et valde producta, oblique truncata; area mediocri, angulatim striato-sulcata; superficie concentrice filiforme striata; declivitate postica prope medium latisulcata et striis radiantibus nonnullis, supra circiter 8, infra ad carinam 4-5, tecta; cardo dentibus numerosis sicut in speciebus typicis instructus.

Height of shell	:	its length	...	...	...	...	0.55
Thickness	„	:	„	...	...	...	0.48

A markedly elongated form, slightly inequivalve, the left valve being a little larger. The striæ on the surface often become almost quite obsolete, in which state the shell shows a great similarity to *Trig. Gamana*, being distinguished from it merely by the more elongated form and comparatively less narrowed anterior side. The posterior radiating ribs near the carina are very characteristic.

Locality.—East of Serdamungalum and near Strípermatúr, in a soft whitish sandstone.

Formation.—Arrialoor group.

ANOMALOCARDIA, Klein, [SCAPHARCA, Gray, 1847] (see p. 339).

1. ANOMALOCARDIA [SCAPHARCA] PONTICERIANA, d'Orbigny, Pl. XVII, Fig. 39, Pl. XVIII, Fig. 1.

1847. *Arca ponticeriana*, d'Orb., Voy. d'Astrolabe, Paléont., pl. v, figs. 29-31,—*eadem* auctorum.

Scaph. testa valde elongata, tumida, antice oblique rotundata, postice sub-carinata, declivitate prope medium sub-sulcata, ad terminationem oblique truncata, inæquivalvi, valva sinistra paulo majori; superficie radiatim costulata, costulis

antice acutis, in medio latiuscule deplanatis seu sub-rotundatis, postice magis numerosis ac approximatis; area latissima, angulatim striata; margine cardinali recto, lineali, multidentato.

Height of shell	:	its length	...	...	...	...	0.74
Thickness	„	:	„	...	...	...	0.81

Although a rather elongated shell, with a broad area, this species appears to be a true *Scapharca* with unequal and radiately ribbed valves. In young specimens the ribs are almost reduced to mere striæ, which fully accounts for their being so indistinctly shown in d'Orbigny's figure; we have a small specimen, about equal to that described by d'Orbigny, and this has the ribs perfectly flattened, but possibly this may be due to the state of preservation, though the shell appears to be quite perfect.

Localities.—North-east of Serdamungalum and near Shillagoody, in coarse sandstone; apparently rare.

Formation.—Arriallor group.

2. ANOMALOCARDIA [SCAPHARCA] CLELLANDI, Forbes, Pl. XVII, Fig. 35.

1846. *Arca Clellandi*, Forb., Trans. Geol. Soc., Lond., vii, p. 139, pl. xvi, fig. 4.

Scaph. testa elongata, compressiuscula, antice oblique sub-rotundata, postice sub-truncata, radiatim costata; umbonibus prominulis, obtusis, approximatis; area ligamentali angustissima; regione cardinali recta, (obsolete denticulata).

Height of shell	:	its length	...	...	...	...	0.52
Thickness	„	:	„	...	...	...	0.31

I have only seen Forbes' original specimen of this shell; it is a cast, with the valves apparently sub-equal, radiately ribbed, and with a very narrow ligamental area; there are only few very slight impressions of the hinge-teeth traceable. It seems to be a very rare shell.

Locality.—Pondicherry.

Formation.—? Valudayur group.

BARBATIA, Gray, 1840, (see p. 340).

1. BARBATIA DECORA, Stoliczka, Pl. XVII, Fig. 38.

Barb. testa elongata, compressiuscula, antice oblique sub-rotundata, postice obtuse sub-carinata, paulo latiuscula, late modiceque oblique truncata; superficie concentric crasse lamellose costata et minute decussatim striata; umbonibus latis, incurvis, valde approximatis; area ligamentali angustissima.

Height of shell	:	its length	...	...	...	...	0.43
Thickness	„	:	„	...	...	...	0.28

Only a single specimen of this beautifully ornamented species was found; it is characterized by being much elongated and rather strongly compressed, with

only a slight indication of the usual pedal and byssal gape of *Barbatia*; the ligamental area is very narrow, the hinge line straight, but the hinge-teeth have not been made visible, the valves being closed.

Locality.—Ninnyoor, in a whitish sandy limestone.

Formation.—Arrialoor group.

2. BARBATIA DIATRETA, *Stoliczka*, Pl. L, Fig. 9.

Barb. testa elongate ovata, valde inæquilaterali, modice inflata, antice breviori, angustata, infra conspicuiter insinuata ac hianti, postice producta, multo latiore, ad marginem oblique sub-rotundata; area mediocri, angulatim striata; umbonibus approximatis, depressiusculis, sub-sulcatis; superficie radiatim striata, striis alteris concentricis incrementi ad intervalla interruptis.

Height of shell	:	its length	...	...	...	...	0.56
Thickness	„	:	„	...	...	...	0.45

A typical form of a *Barbatia* and closely allied to several recent species, particularly some of the varieties of *velata*, with the anterior side of the shell considerably narrow. The flattened slightly sulcated beaks and the posterior broadly rounded shell distinguish this species, though the single specimen is not in very good state of preservation.

Locality.—South-east of Veraghoor, in a brownish finely oolitic rock.

Formation.—Trichinopoly group.

ARCA, *Linné*, 1799, (see p. 341).

1. ARCA FILISTRIATA, *Stoliczka*, Pl. XVII, Fig. 37, Pl. L, Fig. 6.

A. testa elongata, inflata, antice levissime flexuose sub-truncata, infra profunde insinuata, postice latiuscule et convexe sub-truncata, ab umbone sub-carinata, declivitate costa longitudinali divisa; superficie radiatim filiforme striata, striis lamellis incrementi crassiusculis interruptis; area ligamentali longitudine testæ fere æquante, latissima, angulatim striato-sulcata, umbonibus distantibus.

Approximate height of shell at the beaks	:	its length	...	...	0.45
„ thickness „	:	„	...	...	0.42

This is the only species of *Arca* (as restricted) found in the South Indian cretaceous rocks, and the single specimen is somewhat imperfect, but it sufficiently exhibits the characters of the genus. The striation is very similar to that of the last mentioned species of *Barbatia*, but the striæ are more distinctly filiform, and the lamellæ of growth much more strongly developed.

Locality.—North of Odium, in a brownish limestone; very rare.

Formation.—Ootatoor group.

IX. Order,—**MYTILACEA**.

The shells referable to this order represent the Hetero-myaria of authors. All the genera are characterized by a marked inequality of the adductor muscles, the anterior decreasing in size, until it becomes almost obsolete, while the posterior one increases in nearly the same ratio, finally assuming a semilunar or an elongate and curved shape, this being mostly characteristic for the *OSTREACEA*, apparently the lowest organised of all Pelecypoda.

The animals have the mantle margins mostly open, posteriorly partially united and provided with a special anal tube or slit; only in very few, almost exceptional, cases is there also a separate branchial opening present. All the species possess one pair of palps and one of gills on either side; the foot is generally small, rarely elongated and thin, but mostly supplied with a strong byssal gland; the pedal and byssal muscles are always well developed.

The shells have generally a large size and are externally covered with a horny, scaly or papillose, epidermis, internally they are more or less pearly; the ligament is long, often linear, usually sub-external; hinge line long, with a few irregular tubercular teeth or without them; pallial line entire, exceptionally sinuate; muscular scars always unequal.

The different forms can be classed in four families, *PRASINIDÆ*, *MYTILIDÆ*, *PINNIDÆ*, and *AVICULIDÆ*. Their respective relations to the more highly organised Pelecypoda are indicated by the order in which they follow each other, and will be alluded to in more detail subsequently. Some conchologists class the *MYTILIDÆ* before the *ARCACEA*, and place the *AVICULIDÆ* in the *OSTREACEA*. There can be little doubt that this classification is in some respect justifiable, for the *MYTILIDÆ* possess an organisation of the animals which agrees in some points,—as, for instance, in the presence of a special anal opening—with the *LUCINACEA*, but, on the other hand, their shells indicate a lower grade in the system on account of the want of regular hinge-teeth, the marked inequality of the muscular scars, and sometimes of the valves themselves, &c. These characters are to a certain extent common to all the *MYTILACEA*, which form, I believe, a similarly natural group, as do the *ARCACEA*. However, as the apparently highest organised genera of the former order, *Phaseolicama* and *Dreissena*, can hardly be placed higher in the system, than the *NUCULANIDÆ* of the other order, while the lowest forms of the *MYTILACEA*, the *AVICULIDÆ*, are decidedly much more allied to the *OSTREACEA*, than are the corresponding lowest forms of the *ARCACEA*, I think the classification here adopted is more natural than the one usually followed in conchological treatises.

Again, I do not think that a sufficient reason exists for the classification of the *AVICULIDÆ* in the *OSTREACEA*, because these latter never possess an anterior adductor, nor the peculiar horny epidermis of the shell, both of which are very characteristic for all the *MYTILACEA*.

Recent species of this order are not so numerous as the fossil which date from the earliest fossiliferous deposits, and many of the smaller sub-divisions may

be said rather to belong to the past than to the present epoch. Several of the species of *Pinna*, of *Inoceramus*, and of other *AVICULIDÆ*, belong to the most characteristic fossils of various formations.

XXXVII. Family,—*PRASINIDÆ*.

I have placed in this family a few genera the classification of which is somewhat arbitrary. They are *Modiolopsis*, *Hippomya*, *Myoconcha*, *Hippopodium*, *Prasina*, *Julia*, and *Phaseolicama*. Most of the species are fossil forms, which in general shape and character of shell exhibit, as already alluded, distinct relations to the *MYTILIDÆ*. Both have the same elongated, very inequilateral form, more or less narrowed or even pointed at the beaks, and the muscular impressions are in all also similarly placed, subject to slight variations. The character of the external surface is also in both families the same. The hinge-teeth which, however, occur in some of the genera of the present family indicate a relation to those of the *Carditæ*, and for this reason Deshayes associated the fossil *Myoconchæ* with the last named genus, which classification was adopted by some conchologists. In such transitional forms as those included in the present family, single characters should less than any others be considered as leading, and, for the above noted, more general, reasons, I prefer to follow d'Orbigny's suggestions regarding the classification of *Myoconcha* near *Mytilus*. This view has, it appears, also lately been supported by Deshayes, who admits the relation of the recent *Prasina* to the *MYTILIDÆ*. Now, *Prasina*, as well as *Julia*, are generically perhaps hardly separable from the fossil *Hippopodium*, and this again shows in its hinge-character the greatest affinity to *Myoconcha*. *Phaseolicama* may be considered as the representant of the fossil *Modiolopsis*, and it is possible that the recent *Modiolarca*, of which I spoke in the *GLOSSIDÆ* (see p. 184), may also be conveniently grouped in this place.

The distinguishing characters of the shells consist in the elongated, very inequilateral form of the valves, with moderately tumid beaks, more or less smooth surface, two unequal muscular impressions, of which the anterior is smaller, but more deeply excavated, the posterior large, shallow, and sometimes rather ventrally placed. A partial division of this muscular scar leads me to suppose that the greater part of the impression is produced by the pedal muscle and not by the posterior adductor, to which, as in the *MYTILIDÆ*, very likely only the upper or dorsal part of the impression is to be attributed. The hinge, as far as known, appears to consist of one elongated cardinal tooth in each valve; the ligament is external, long, supported by thickened fulcra. Only in *Modiolopsis* and *Phaseolicama* no hinge-teeth have been observed.

Of the two or three recent genera, *Prasina*, *Julia*, and *Phaseolicama*, the animal of only the last named one has been recorded. It appears to have the mantle margins united, with one pedal and two siphonal openings. This clearly indicates a passage to some of the *DREISSENIDÆ*, as already pointed out.

1. *Modiolopsis*, Hall, 1847, (Palæont., New York, I, 157). Shell elongated, very inequilateral, with the beaks anterior, sub-terminal, and close together; thin,

hinge toothless, with the areal margin more or less straight, and a very slight ligamental furrow; ventral margin in front of the middle generally insinuated, the posterior part of the shell being often much wider and higher than the anterior; anterior muscular impression distinct and large; type, *M. (Cypricardites) modiolaris*, Con.

Hall does not mention the existence of a posterior muscular scar, and thinks that *Modiolopsis* possesses only one adductor muscle; but judging from the very great similarity of the shells of *Modiolopsis* and *Modiola*, it seems very probable that a posterior adductor also exists in the present genus, but it may be represented by only a very narrow and faint impression along the posterior upper margin of the shell, difficult to be traced in fossil specimens. In many recent *Modiolæ* this posterior adductor is also barely traceable, and those shells are, strictly speaking, undistinguishable from *Modiolopsis*, unless the great size of the anterior adductor is really so prominent and constant a character as it is stated to be, though this appears to be somewhat doubtful. The genus includes only palæozoic,— mostly silurian,— species.

2. *Hippomya*, Salter, 18?? (Woodward's Man., 2nd edit., p. 423). "Shell gibbous, with anterior inflated close beaks, a long cardinal edge; anterior edge short and separated by a strong sinus from the inflated posterior ridge and slope." One Devonian species is said to be known; I am not acquainted with it.

3. *Myoconcha*, Sow., 1825, (Min. Conch., V, p. 103, pl. 467). Very elongated, anteriorly narrow, with terminal, or sub-terminal, beaks, of solid structure; hinge sometimes almost toothless, or with an elongated, upper cardinal tooth in each valve, and sometimes with a similar remote posterior lateral; ligament external, placed in a long and deep groove, and supported by strong fulcra; anterior muscular impression small, situated near the interiorly thickened anterior end, often margined posteriorly by a raised rib; a small impression above and behind the anterior muscular scar indicates the presence of a strong pedal muscle, and this again would seem to indicate a strong foot; posterior muscular scar much larger than the anterior, roundly oval; pallial line entire; surface concentrically striated, generally with a few radiating ribs along the posterior upper margin; type, *M. crassa*, Sow., from middle jurassic rocks.

The first species of this genus appear in the upper carboniferous and Permian deposits; these species have the hinge-teeth very slightly developed and sometimes almost obsolete, but the anterior muscular scar is well marked. They strongly resemble *Modiolopsis* and seem to replace that genus.

Deshayes (Paris foss., 2nd edit., I, p. 752,) identifies *Myoconcha* and *Hippopodium* with *Cardita*, which seems to me to be inadmissible; and there is scarcely any student of fossil conchology who will, I think, now adopt Deshayes' views. *Myoconcha* forms a very good genus by itself, characteristic of the upper palæozoic and mesozoic deposits; the few species noticed from the tertiaries are doubtful. Gray's suggestion to classify the genus in the family *DREISSENIDÆ* seems more correct. But as *Myoconcha* has the region upon which the anterior

muscular scar is situated only thickened, not forming a distinct hinge plate which all the *DREISSENIDÆ* possess, the present classification appears to me preferable.

Modiolina, Müller, 1851. Müller described (Petref. der Aach. Kreidef., 1847, p. 36), as *Lithodomus discrepans* a species which is distinguished by a very elongated narrow form, somewhat of the type of the recent *L. palmula*, Hanl., from Panama, but the large anterior muscular scar rests on a thickened shelly base and is followed posteriorly and above by one or two smaller scars, probably produced by a division of the pedal muscle. In pt. II of the same work (1851), p. 69, Müller proposed for the species in question a new generic name, "*Modiolina*," calling it *M. Bosqueti*; the change of the specific name cannot, of course, be accepted, but there is also no reason for establishing a new genus. I have examined the hinge of both valves, and find that there is a strong hinge-tooth in each superseded by the usual ligamental groove, which is nearly internal. In my specimen there is only one pedal impression behind the muscular scar.

4. *Hippopodium*, Sow., 1821, (Min. Con., III, p. 91, pl. 250). Shell ovate, elongated, tumid, of solid structure, with sub-anterior, incurved beaks and an excavated lunula; hinge in the right valve with an elongated, almost horizontally placed tooth and a pit below it, into which fits the tooth of the other valve; ligament external, long, supported by strong fulera; muscular scars well marked, the anterior much smaller than the posterior; pallial impression entire; type, *H. ponderosum*, Sow., from the Lias. Several new species are briefly characterized by d'Orbigny in his Prodrôme from jurassic deposits.

5. *Prasina*, Desh., 1863, (Mollusques de l'île Réunion, (ext.), p. 25; Journ. de Conch., 1863, vol. III, p. 396). Shell oblong, solid, moderately inflated, with sub-anterior incurved beaks, anterior end somewhat narrowly produced, lunula deep; hinge with one strong tooth in each valve; ligament external, long, placed in a groove resting on distinct fulera; muscular scars two, one smaller sub-median, the other larger close to former and almost united to it, being sub-central and near the ventral side; pallial line indistinct; type, *P. Bourbonica*, recent from Bourbon; the valves are smaragd-green when fresh and of small size.

I have already noticed the extreme similarity of this single recent species to the fossil *Hippopodium*, and if the position of the posterior muscular scar in the latter genus should prove to be similar to that of *Prasina*, there would barely remain sufficient ground for separating the two.

6. *Julia*, Gould, 1862, (Proc. Bost. Soc., VIII, p. 280). Quite similar to *Prasina* in the form of the shell and in the teeth of the hinge, but the muscular scar is said to be single, sub-central, and tripartite; the type is *J. exquisita*, Gould, from the Sandwich Islands, apparently differing from *Pras. Bourbonica* merely by a fine radiating striation. Semper (Journ. de Conch., 1865, V, 296,) suggests that this genus may be identical with the former, and this seems very probable, for it is most difficult to trace even in quite fresh specimens of *Prasina* the exact form of the muscular scars.

7. *Phaseolicama*, Valenc., (Chenu, Manuel de Conch., II, 157). Shell ovately elongated, equivalve, inflated, with the beaks sub-anterior, hinge toothless; the muscular scars are stated to be long and strong, and the pallial line complete; type, *Ph. Magellanica*, Val. The animal has the mantle with three openings, the anterior being for the passage of the foot, the gills and palps are elongated. Chenu introduced this genus in the family *MYTILIDÆ*: its form is very similar to that of *Modiola*, but it would appear that the mantle margins are to a great extent united.

LIST OF CRETACEOUS SPECIES.

Pictet and Campiche (Mat. p. l. Pal. Suisse, IV^{me} ser., 3^{me} part., p. 344,) admit the following species:—

1-6.—*Myoconcha Sabaudiana*, Lorient, *gaultina*, Piet. and Camp., *cretacea*, d'Orb., *angulata*, d'Orb., *dilatata* Zittel, and *Requieniana*, Math.

7-9.—*M. elliptica*, Römer, *minima*, Reuss, and *M. (Modiolina) discrepans*, Müller.

M. supracretacea, d'Orb., is a problematic species, and *M. Neocomiensis*, d'Orb., is supposed to be identical with *Sabaudiana*. *M. cretacea* is given by Eichwald also from the so-called neocomien beds at Khoroshowo and from glauconitic beds near Orenburg, and *M. minima* from the Cenomanien of the neighbourhood of Kiev, (Leth. ross., X^{me} livr., 1867, pp. 538 and 540).

10.—*M. Strajewskiana*, d'Orb., (ibid. p. 539,) is also placed by the same author in the neocomien.

11.—*M. Ferreti*, Guéranger, Album paléon. de la Sarthe, 1867, pl. xxii, fig. 8.

12.—*M. gracilis*, Drescher, Zeitsch. d. deutsch. geol. Gesellsch., vol. xv, 1863, p. 350.

13.—*M. sub-ovata* is the only species which occurs in the South Indian cretaceous rocks.

MYOCONCHA, Sowerby, 1825, (*vide* p. 360).

1. MYOCONCHA SUB-OVATA, Stoliczka, Pl. XXIII, Fig. 1.

Myoc. testa sub-ovata, modice inflata, crassa, antice anguste obtusata, postice late sub-rotundata, margine dorsali leviter curvato, ventrali sub-recto, prope terminationem anteriorem paulo insinuato; umbonibus sub-anticis, depressiusculis; superficie striis incrementi lamellosis et ad marginem dorsalem duabus costulis radiantibus notata.

Length	:	greatest height of valves	...	...	...	...	2.02
"	:	" thickness "	...	...	...	...	2.77

The elongately ovate shape and rather uniform convexity of the valves readily distinguish the present species from any other cretaceous form. The shell is of considerable thickness, but not well preserved on the figured specimen, its surface being somewhat weathered off; it shows only strong concentric striae of growth. Another specimen shows near the dorsal margin two ribs which begin at the apex and proceed posteriorly in a manner similar to that seen in *M. cretacea*. This second specimen, being partially a cast, also exhibits the impressions of the two adductors, which are of the usual form: the anterior situated on a thick

plate somewhat in front and below the apex, while the posterior is very large, elongately ovate, and situated behind the middle of the dorsal margin.

Locality.—Koloture, in a light brownish conglomeratic rock.

Formation.—Trichinopoly group, but very close to the boundary of the Arrialoor group, which just in this place is somewhat uncertain.

XXXVIII. *Family*,—*MYTILIDÆ*.

The animals of *MYTILIDÆ* are distinguished by an elongated, anteriorly narrowed or acuminate form; they have a mantle consisting of several layers, the outer of which is always disunited, secreting on its inner side the horny epidermis, on its outer terminal end the calcareous substance of the shell; the innermost layer is sometimes partially united, and all of them are united dorsally along the ligamental region; the branchial region and anal opening are variable in extent and form; there are always two gills and two palpi on each side; the foot is of variable size, generally small, cylindrical, grooved below, with a large byssal gland at its lower base, the pedal and byssal muscles being strongly developed; the adductors are always very unequal, the anterior small, marginal near the apex, often very thin; the posterior conspicuously rounded.

The shells have an elongately ovate or more or less triangular shape, they are always covered with a horny epidermis, internally more or less nacreous; the hinge has sometimes a few irregular pliciform teeth, but, as a rule, it is toothless; the ligament is long, linear, more or less internal; pallial impression mostly entire, very rarely sinuated; below the beaks the valves are generally somewhat gaping for the passage of the foot and byssus.

Most of the species are marine; a few also occur in brackish water and a few others are fluviatile; they usually live gregarious and form nests of foreign substances connected by their byssus; a few have burrowing habits.

There is not much variation in the form of the shells belonging to the present family, the shape altering between triangularly ovate and elongately ovate, but there are essential differences upon record in the organisation of the animals. According to these I have grouped the various forms in three sub-families, and shall briefly point out the characteristics of each. The fossil genera will be classified according to the most marked relations which the characters of their shells exhibit with recent forms:—

a. DREISSENINÆ. The type of this sub-family is *Dreissena polymorpha*, Pallas, which has the external mantle margins open and finely ciliated, the internal closed, with one pedal and byssal opening ventrally below the beaks, and two siphonal openings posteriorly, both produced into shorter or longer tubes. The lower or inhalant siphon is larger and ciliated at the margin, the exhalant smaller and smooth; the palpi are rather small and triangularly elongated, the pedal muscle strong and short; posterior adductor rounded, large, anterior smaller, attached to the inner side of an umbonal plate.

Besides the fluviatile *Dreissena* there is another recent marine genus, *Septifer*, referable to this sub-family. It agrees in the development of the hinge plate with the former, but I have not as yet been able to observe the animal. The extinct allied genera are *Hoplomytilus*, *Anthracoptera*, and *Myalina*.

b. *CRENELLINÆ*. The animals of this sub-family have the mantle margins ventrally mostly disunited, posteriorly in the branchial region produced and ciliated, forming a kind of fold, which is superseded by a more or less produced anal tube; the palpi are of moderate size and narrowly elongated, the foot very long, and exsertile, with a small byssal gland at the base. In *Crenella* the foot is club-shaped at the end and the excurrent tube sessile; in *Modiolaria* the byssal gland is larger, often excreting a strong byssus, and the excurrent tube is elongated. The pedal muscles are rather thin and long; the anterior adductor thin, marginal, anterior; the posterior oblong and much stronger.

The genera referable to this sub-family are *Crenella*, *Dacridium*, *Modiolaria*, *Arcoperna*, and *Myrina*.

c. *MYTILINÆ*. These also have the mantle margins nearly quite open, posteriorly towards the upper end with a branchial fold, ciliated at the margin, and superseded by a separate exhalant opening, not produced into a tube, but merely represented by a slit; the palpi are long, narrow, with pointed and often curled ends, on the inner side striated; the gills originate between the two palpi and extend posteriorly, becoming gradually narrower; their ends are somewhat turned upwards, but free, not grown to each other or to the mantle, as is usually stated in conchological treatises. At least in a number of species which I have examined, as, for instance, *Mytilus smaragdinus* or *Modiola tulipa*, the gills are free, and if they are attached in others, I would be inclined to look upon this more as an exception than as a rule, because in many *AVICULIDÆ*, which I examined on this point, I also found the gills free posteriorly.

There are only three genera referable to this sub-family, and they somewhat differ in habitat and also in organisation. *Lithodomus* burrows in solid substances, it has a small foot, and the byssus is in full grown specimens not developed; the anterior adductor is well marked, the pedal muscles moderate; the posterior branchial edges of the mantle become in some specimens greatly extended. *Modiola* spins nests of foreign substances with its byssus, or lives in excavations of rock. It has the foot very elongated, thin, sometimes slightly thickened at the end; the anterior adductor is narrow, thin, marginal; the pedal muscles, specially the anterior pair, are rather thin and long. *Mytilus* has the labial palps almost half as long as the whole animal; the gills strongly bent upwards posteriorly; the foot short, sub-cylindrical, and thick, the pedal muscles strong, the anterior adductor very thin, marginal, and sometimes almost obsolete.

The transitions from the one to the other of these three genera are, as regards organisation of the animal and the shape of the shell, so manifold and marked that it seems most correct to keep all three within one sub-family. As to the propriety of distinguishing the three genera, which are by some conchologists united under

the single name *Mytilus*, there cannot be, however, any doubt. They represent three well-marked types of shells.

Another question arises as to whether it be more correct to unite the three sub-families just pointed out into one family, or to divide them into two or even three. The sub-division of the *MYTILIDÆ* which I have here adopted is mainly based upon the development of the in- and ex-halant openings. As regards this point of organisation the *MYTILIDÆ* offer a most marked parallel to the *CARDIIDÆ*. In both we find that certain marine forms exhibit a gradual transition into others inhabiting brackish and fresh water, and that while there is but very little change in the general form and structure of the shell, certain organs of the animals attain a higher development; namely, the simple siphonal folds of the mantle become first slightly and then more markedly prolonged into tubes, and at the same time the mantle margins grow together. Upon this distinction the separation of the marine *CARDIINÆ* and the fluviatile *LYMNOCARDIINÆ* has been based. Now, there is actually little difference between the purely marine *MYTILINÆ* and the partially brackish, partially marine *CRENELLINÆ*, both possessing an open branchial mantle-fold, and the former a simple enclosed anal slit, the latter a regular more or less prolonged anal tube; both have, as a rule, the mantle margins disunited, only *Crenella* appears to have the ventral margins partially united. This form, therefore, clearly indicates a passage to the *DREISSENINÆ*, the typical forms of which have the mantle closed, though it is not yet certain whether the same character applies to the other recent genus of the sub-family, *Septifer* (the animal of which is believed not to differ from *Mytilus*). Looking thus at the relations of the animals, in which a gradual change of certain organs can be traced, and considering at the same time the very close affinity of the shells, I do not think that a separation of the *DREISSENINÆ* into a distinct family from the *MYTILIDÆ* can justly be considered as natural in the present state of our knowledge. Much less do I believe in the close affinities of the genus *Dreissena* to *Sphærium* (*Cyclas*), or to *Cardita*, an opinion which has lately found favor among some European conchologists.

The *MYTILIDÆ* class among the oldest Pelecypoda. They already appear in the palæozoic strata, and continue in increasing variety and number of species up to the present date.

a. Sub-family,—*DREISSENINÆ*.

Anterior muscular scar resting on a thickened plate near the apex of the shell, hinge sometimes with an obsolete long tooth, fulcrum of ligament strong; pallial line entire, rarely sinuated.

1. *Hoplomytilus*, Sandberger, 1856, (Verst. des Rhein. Schichtensystems in Nassau, p. 281). Sub-triangular, with concentric striæ of growth; beaks pointed, an elongated plate extends from below the beak, where it is attached to the anterior side and for some distance along the dorsal margin; next to it lies a rib-like tooth in the right valve corresponding to a groove in the left one, and then follows

the ligamental furrow. The type species *H. crassus*, Sandb., is from Devonian beds of Villmar. The genus differs from *Dreissena* merely by having the umbonal plate attached chiefly along the dorsal side of the shell.

2. (*Anthracoptera*, Salter, 1863). In connection with the last genus should be mentioned the peculiar fossil described by Gabb apparently from the coal-measures of North America as *Myalina deltoidea*, (Proc. Phil. Acad., 1859, p. 297, and 1860, p. 55, pl. 7, fig. 1). The shell resembles the type of *Hoplomytilus* in form, but the description of the hinge is not quite intelligible. Gabb says, "inside, the cardinal third of the shell shows an alation which is invisible exteriorly." The figure appears to indicate that a kind of lamina, or a thickening, extends from the beak some distance along the dorsal edge, gradually becoming wider and passing into the thickness of the shell. Salter figured a similar shell from the coal-measures of Nova Scotia (Quart. Journ. Geol. Soc., Lond., xix, 1863, p. 79, fig. 3, and p. 80), and suggested the name *Anthracoptera* for it, but of the only species *A. Carbonaria* the hinge is, I believe, as yet unknown. It is possible that the two species belong to a genus distinct both from the former and from the next.

3. *Myalina*, Koninck, 1842, (An. foss. Carb. de Belg., p. 125). Elongately sub-trigonal, with pointed beaks; each with a small internal septum, ligamental area broad, with the ligament internal, and several longitudinal furrows between it and the outer posterior margin; type, *M. Goldfussiana*, K., from carboniferous rocks. The genus may be also represented in triassic rocks through such species as *Mytilus Münsteri*, Klipst., (see Laube in Denksch. Acad., Wien, xxv, pt. ii, p. 44, pl. 16, fig. 5). It is said to belong to the *AVICULIDÆ*, but the relation which the typical forms show with species like *Dreissena* [*Congeria*] *spathulata*, Partsch, clearly indicate the natural grouping of the genus.

4. *Septifer*, Recluz, 1848. Shell elongated, with the beaks pointed, anterior, internally often with a few terminal small hinge-teeth and a large septum, anterior ventral side with a byssal opening and usually incurved margins; surface mostly radiately striated and covered with a thin epidermis; inner margin of shell often denticulated; anterior muscular impression small, rounded, posterior elongated and often somewhat irregular; pallial line entire; type, *S. bilocularis*, Linn.

5. *Dreissena*,* Van Beneden, 1835. Triangular or irregularly quadrangular, with pointed beaks and a ridge running from it along the dorsal margin; surface smooth, with more or less distinct striæ of growth, gaping at the anterior ventral side; hinge usually with an apical tooth in the right valve; umbonal plate occupying the whole of the antero-terminal part, more or less developed, and posteriorly sometimes provided with a small pit, which is produced either by the labial suspensor or the pedal muscle; posterior muscular impression larger, rounded, or oval; ligament internal or sub-internal, internally accompanied by a longitudinal

* Setting aside the right to priority of Münster's name *Enocephalus*, the other three names, *Dreissena*, *Tichogonia*, and *Congeria*, may be considered as possessing equal claim to be accepted, all having been published and equally well characterized within the same year, 1835. From Fischer's historical account (Journ. de Conch., 1858, VII, p. 125), it, however, appears that Van Beneden's name was published earliest.

† Many of the species are *Myalina* in appearance, but as to connectivity with the *Myalina* of the *Myalina*, while the outer shell layer is as distinctly pinnate as that of *Myalina* or *Pinnia*. The cartilage area, and processes are also exactly as in *Myalina*, admitted by all to belong to the *Aviculidæ*. These facts, I think, "clearly indicate the natural grouping of the genus" with the *Aviculidæ*.

ridge; pallial impression simple or sinuated; type, *D. polymorpha*, Pall. There are said to be about eighteen recent species known from Africa and America, and about twelve fossil, most of them occurring in the fresh and brackish water, upper miocene, deposits of Central and Eastern Europe.

H. and A. Adams propose for a number of recent species of the type of *D. Africana*, van Bened., the sub-generic name *Praxis* on account of the presence of a certain small lamina affixed to the septum. I do not know what the real character of this lamina is, (for I have none of those species to compare), but if reference is made to the small projecting pit near the septum, which is so well developed in all the tertiary fossil species described by Partsch, who specially alluded to it in his description of the genus, the name *Congeria* has priority before that of *Praxis* and should be reserved for that group of shells, for the pit does not exist in the type species of recent *Dreissena*. (*Congeria*, vide Hörnes, Foss. Moll. des Wiener Beckens, vol. ii, p. 360). It appears to be this small pit attached to the septum to which Conrad in his newly proposed genus *Mytilopsis* makes reference. His characteristic (Proc. Phil. Acad., 1857, p. 167,) is as follows: "Shell mytiliform, attached by a byssus; hinge with a septum beneath, which on the cardinal side is a triangular cup-shaped process; cartilage groove rather deep;" type, *Mytilus leucophæatus*, Con., from the rivers of Virginia.

Thus the name *Dreissena* will stand for the type species *D. polymorpha*, and *Tichogonia* is a synonym of it. *Congeria* will have to be retained (? sub-generically) for the species of the type of *Cong. sub-globosa*, *spathulata*, &c., of Partsch, and the names *Praxis* and *Mytilopsis* appear to be synonyms of this second type.

Fuchs, in a recent communication* about some upper tertiary fossils from the Banate, (Hungary,) notes a *Dreissena Schröckingeri*, in which the septum appears to be transformed into a regular large anterior muscular scar, and the pallial line shows a deep posterior sinus. Still more recently† the same author proposes for this species the new generic name *Dreissenomya*.

b. *Sub-family*,—CRENELLINÆ.

Shell elongately tumid, thin, with sub-terminal slightly swollen beaks, two muscular scars, of which the posterior is larger, outer surface of valves entirely or partially radiately striated (except in *Myrina*); hinge line often denticulate; ligament almost quite internal, in a linear groove, more or less extending posteriorly.

6. *Crenella*, Brown, 1827. Shell oval or rhombic, thin, moderately inflated, radiately striated, hinge with one tooth in each valve, simple or crenulated, and produced parallel to the hinge margin; ligament very thin, sub-internal, supported by a distinct plate; muscular scars two, faint, unequal; pallial line entire, indistinct; type, *Cr. decussata*, Montg., recent from British seas. Fossil species occur in tertiary and cretaceous deposits, but those from older ones are doubtful.

* Verhandlungen der geol. Reichsanstalt, April, 1870, p. 97.

† *Ibidem*, p. 320.

Philippi (Handb., p. 263,) already notices the animal of the type species according to Müller's figure of it. Jeffreys (Brit. Conch., II, p. 130 et seq.,) describes it also, as well as that of *Cr. rhombea*, Berk. The former author says that there is 'in front only a small opening in the mantle' for the protrusion of the foot, and posteriorly a single small sessile siphonal opening. This seems to be approximately correct, though the pedal opening cannot be very small. The latter author states that in both species the mantle is entirely open in front, 'folded behind into a sessile excurrent tube.' This last statement would appear to refer to the sessile exhalant opening, which seems to be quite distinct and separated from the general anterior opening of the mantle. The foot is very elongated, sub-cylindrical, thickened towards the end, and expansile into a small creeping disc; it very much resembles that of *Lucina* and allied genera. No special byssus appears to exist, but the animal was observed to spin a few byssal threads for its temporary attachment.

Myoparo costatus, Lea, (Cont. Geol., 1833, p. 74), which Conrad (in Morton's Syn. org. rem. cret. form., 1834, App. p. 8,) identifies with his *Stalagmium margaritaceum*, is generically considered the same as *Crenella*. Lea's description is not quite sufficient to decide that point; it notices a number of distinct hinge-teeth on either side, but it does not allude to the peculiarity of the ligamental or cartilage plate. Lea's figure would indicate the presence of an elongated internal pit, and in such a case the species might be generically identical with *Stalagmium Nystii*, Galeot., as suggested by Nyst; d'Orbigny proposed (in 1850) for this last species the name *Nucunella* (see p. 333). Good figures of these shells are a great desideratum. The character of the hinge of *Nucunella Nystii* appears to me sufficiently to indicate that the species in question belongs to the *ARCIDÆ*, but if Lea's species should prove to be generically the same, the name *Nucunella* would have to be replaced by *Myoparo*, or *Stalagmium*, though I do not know whether the latter can take priority before the former. *Nuculocardia* of d'Orbigny is to all appearance cogeneric with *Crenella*.

7. *Dacridium*, Torell, 1859, (Bidr. till Spitzbergen's Molluskenfauna). I only know this name from Troschel's extract in Arch. f. Naturgesch., vol. xxvi, p. 354). He says that the genus has been proposed for a shell considered to be identical with *Modiola vitrea*. It is distinguished by *dentibus crenulatis*, 'antico tuberculiformi, postico elongato, cristis suffulti(s) decurrentibus.'

8. *Modiolaria*, Beck, 1846. Elongately oval, or sub-rhomboidal, beaks sub-anterior, surface radiately striated, the striæ being obsolete about the middle of the ventral side, where the margin is generally somewhat indented; the striated portions of the margins are crenulate; hinge edentulous, or sometimes with one or two small, sub-obsolete teeth, the marginal crenulation near the beaks is often stronger than at the posterior end; type, *M. discors*, Linné.

The animals of the present genus are, as already noticed, closely allied to those of *Crenella*, but they differ essentially from those of *Modiola*, though the shells resemble each other very much, and if in fossil species the outer striation becomes

+ The ligament is internal in the type species.

obsolete, they are actually not to be distinguished. Species of *Modiolaria* are represented in cainozoic as well as in mesozoic rocks.

9. *Arcoperna*, Con., 1865, (Am. Journ. Conch., I, pp. 10 and 140). Oval or oblong, thin, moderately inflated, with terminal, or very nearly terminal, incurved beaks, surface finely radiately striated, somewhat stronger anteriorly, producing a distinct crenulation at the margin; hinge edentulous, ligament thin, long, situated in a fine marginal furrow of the internal side; muscular scars distinct, the anterior slightly smaller than the posterior, pallial impression simple; type, *A. filosa*, Con., from eocene rocks of Mississippi. Conrad says that Deshayes' *Mod. radiolata*, (Paris. foss., 2nd edit., vol. ii, p. 22,) is cogenetic with the above species. Its relation to the short, oval species of *Modiola* is very great, but the well marked and comparatively large anterior muscular scar, internal ligament, and fine radiating striation may serve as distinction. In general character *Arcoperna* strongly recalls the type of shell noticed as *Phaseolicama*. It is not improbable that the recent *Lith. cinnamominus*, Chem., is a recent representant of *Arcoperna*, while, on the other hand, cretaceous species, like *Mytilus pileopsis*, d'Orb., and a few others, are equally correctly referable to it, as to *Crenella*, or to any of the allied genera.

10. *Myrina*, H. and A. Adams, 1857. Oblong, sub-equilateral, covered with brown cuticle, smooth, pearly internally; hinge edentulous, ligament internal, linear, supported by a distinct rib; muscular scars distinct, wide apart; pallial impressions entire; type, *M. pelagica*, Forb., a recent species found on floating masses off the Cape of Good Hope. The animal is said to be byssiferous. The shell differs from *Arcoperna* merely by the smooth surface and more centrally placed beaks.

c. Sub-family,—MYTILINÆ.

Shell elongated, with sub-terminal or terminal and pointed beaks, hinge toothless, anterior muscular scar small, marginal, posterior scar large and elongated, pallial line entire.

11. *Lithodomus*,* Cuv., 1817. Shell sub-cylindrical, inflated, moderately solid, very inequilateral, the beaks being almost anterior and incurved, very close together; surface smooth or often finely corrugated; hinge edentulous, ligament marginal, thin, sub-internal; muscular scars unequal, faint; type, *Lith. lithophaga*, Linn., from the Mediterranean.

Young *Lithodomi* are stated by Cuvier to attach themselves by a byssus, which subsequently, when the animals have excavated a hole, becomes obsolete. This must apply either to some (perhaps not typical) species only, or to the strictly embryonic state, for I have repeatedly found young specimens of 2 m. m. length, (belonging to a species which grows 80 m. m. long,) perfectly enclosed in their cavity. I don't think that old *Lithodomi* would at all be able to bore a hole.

* I think that it is preferable to retain Cuvier's name before any other. Bolten's name *Lithophaga* (also often used as a family name by other authors) appears to have no claim to priority, but M. von Mühlfeld's *Lithophagus* would have this, were it not a mere repetition of the specific appellation *Mytilus lithophagus*, Linn., this being the type of *Lithodomus*.

There appear to be two or three distinct sections represented in the genus. The one, of the same type as *Lith. lithophagus*, always, I believe, excavates hard substances from the earliest stage of life, and its existence depends upon the presence of solid material, rock or coral, or hard soil. This group is distinguished by a strictly cylindrical form and very small adpressed beaks. *Lith. Gruneri* is the extreme type of this group, having the beaks somewhat flattened and rather removed from the anterior end.

11a. The second group is represented by species like *Lith. splendida*, Dunk., for which Mörch suggested the name *Botula* (1852?). The species are oblong, of thin structure, with flattened, broad, sub-terminal incurved beaks; the cuticle is at the posterior side often produced into long hairy filaments. On the whole, these species barely differ from *Modiola*, except by their habitat. They attach themselves when young with a byssus in cavities and crevices of rocks and coral. I found them also in sponges and starfishes, but I am not certain whether they really excavate solid rock in the same manner as the true *Lithodomi* do. It is, therefore, doubtful whether they should be entirely separated from *Modiola*; they perhaps rather form a sub-genus of this genus than of *Lithodomus*.

11b. A third sub-genus is recorded by H. and A. Adams under the name of *Leiosolenus*, Carpenter, with the only species *Lith. spatiosa*, in which the animal is said to excavate its burrow by the aperture being prolonged into a kind of a tube. I am not acquainted with the species.

Species of *Lithodomus* (as restricted) occur from the lower mesozoic rocks upwards, but they are not numerous, as may naturally be expected from the difficulty accompanying their discovery. Fossil forms of the type *Botula* are not separable from *Modiola*, except perhaps by the more distinctly flattened and incurved beaks, which are very nearly terminal.

12. *Modiola*,* Lamarck, 1799, (*Perna*, Adanson, 1756, and *Volsella*, Scopoli, 1777, ex-parte). Oblong, inequilateral, with the beaks sub-anterior, incurved, posteriorly more or less produced and expanded, of thin structure; surface smooth, or sometimes partially radiately striated, and towards the margin more or less corrugate; hinge generally edentulous, sometimes with a few sub-obsolete teeth; ligament supported by thin fulcra, sub-internal; muscular scars very unequal, the anterior much smaller than the posterior, and both not very distinct, as is also the pallial impression; type, *Modiola modiolus*, Linn.

Species of *Modiola* occur from the oldest deposits upwards. They were already very numerous during jurassic and cretaceous formations, and the species during the latter are almost quite as numerous as those known recent.

H. and A. Adams quote two sub-genera, *Brachydontes*, Swains., and *Adula*, H. and A. Adams.

* It seems quite unnecessary to replace Lamarck's name by either of the two older names, *Perna* and *Volsella*, for none of them had been used in any restricted sense before the introduction of the name *Modiola*; both included a number of various genera.

12a. The former may be retained for a small number of species of the type of *Mod. plicatula*, Lam., with surface radiately striated and the anterior end narrowed and obtuse, but it appears also to include a number of heterogeneous species, some of which evidently are striated *Mytili*, and others seem to be more correctly classed with *Modiolaria*.

12b. *Adula* has been proposed for a single species, *A. soleniformis*, d'Orb., a well marked solenoid form, thin, with sub-central beaks, like *Myrina*, a long hinge line and with the posterior termination obliquely truncate. Carpenter (in Ann. Mag. Nat. Hist., 3rd ser., xiv, p. 424,) suggests that the characters of the sub-genus be "enlarged to receive the shells of lithophagoid shape which are moored by byssus, like *Modiola*." The same author also says that *Adula falcata*, Gld., is the largest species of the sub-genus, and lives in holes of clay together with *A. stylina* and other boring shells. It is also suggested that *Lithodomus parasiticus*, Desh., and *Lith. cinnamominus*, Chem. (*cinnamomeus*, Brug.) belong to the same sub-genus. The latter species, I have already noticed, is closely allied in form to Conrad's *Arcoperna* (see p. 369), although both are perhaps equally correctly referable to the sub-genus *Botula*, but I doubt the propriety of associating them with the typical species of *Adula*. Carpenter states in the characteristic of *Adula* that the anterior part of the shell is the longer one, which seems inconsistent with the description of his new species and the figure of the type in Chenu's Manual.

Farther researches in the comparison of recent and fossil species and the examination of the animals make it probable that a thorough reformation in the generic and sub-generic groups of *Modiola* must sooner or later be carried out. The materials are, however, as yet quite insufficient in order to make such a re-arrangement really successful.

13. *Mytilus*, Linn., 1758. Shell sub-trigonal, narrow, and more or less pointed at the beaks, broader and generally rounded behind; beaks terminal or very nearly so; hinge without distinct teeth, sometimes with one or two small tubercles, and in the radiately striated species generally with a slightly crenulated margin; ligament partially attached on the internal side and supported by special fulcra, but always also externally visible; muscular scars very unequal, the anterior being much smaller than the posterior, which is often of irregular shape; both are, however, rather indistinct, and so is also the simple pallial line; type, *Myt. edulis*, Linn.

13a. The name *Mytilus** has been restricted to the species provided with smooth concentric striæ of growth, sometimes also with a partially scabrous cuticle. The radiately striated or ribbed species of the same type as *M. Magellanicus*, Chem., have been, according to H. and A. Adams, separated into a special sub-genus under the name *Aulacomya*. They form but a subordinate section of the former.

13b. *Stavelia* has been suggested by Gray for Dunker's *M. tortus* and *horridus* (see Proc. Zool. Soc., Lond., 1858, and An. Mag. Nat. Hist., 3rd ser., ii, p. 62).

* Schlotheim applied to a number of fossil MYTILIDÆ the name *Mytulites*.

The shells are stated to be inequivalve, though this character appears to be barely noticeable in some of the figured specimens. The posterior part of the shell is covered with a paleaceous cuticle, but this also occurs in other species of *Mytili* and *Modiolæ*. It seems hardly appropriate to create a new name for these forms as distinct from *Mytilus*.

Fossil *Mytili* occur rarely in palæozoic strata and appear gradually to increase from that time up to the present. They are now less numerous than the *Modiolæ*, and the same also seems to have been the case already during the mesozoic epoch.

LIST OF CRETACEOUS SPECIES OF *MYTILIDÆ*.

The correct generic determination of the various cretaceous species is accompanied with considerable difficulties, although, as a rule, fossil *MYTILIDÆ* are found well preserved; but this does not apply to the internal characters, and genera like *Dreissena*, or *Congeria*, and *Septifer* can satisfactorily be separated from their allies merely by the study of the internal structure of the shell.

The sub-family *DREISSENINÆ* is represented in the cretaceous deposits only by a few species which are with great probability referable to *Septifer*. Of the *CRENELLINÆ* a few species of *Modiolaria* and *Crenella* (including *Myoparo* or *Stalagmium*) occur. Most of the species known belong, however, to *Lithodomus*, *Modiola*, and *Mytilus* which, including a few less important sub-genera, form the third sub-family. The distinction of the fossil species of the three last named genera is, even from mere external appearance, not more difficult than that of recent species, and it is approved of by most palæontologists in opposition to Deshayes, who unites them under the single Linnean name *Mytilus*.

In order to avoid numerous repetitions of references to literature, I shall again follow in the enumeration of the species Pictet and Campiche who class our shells in two genera, *Mytilus* and *Lithodomus* (Mat. p. l. Pal. Suisse, ivme ser., 3^{me} part., 1867, p. 506 et seq.). Later additions are comparatively few.

Mytilus, *Modiola*, *Septifer*, and *Crenella*.

1.—*Myt. lanceolatus*,* Sow. (? including *edentulus*, *tridens*, *prælongus*, and *inæquivalvis* of the same author).

2-4.—*Myt. Couloni*, Marc., *Michaillensis*, P. and C., *Sanctæ-crucis*, P. and C., may with equal probability belong to *Septifer* or to *Mytilus*.

5.—*Myt. Cuvieri*, Math., is a *Modiola*, under which genus it was originally described.

6-7.—*Myt. Dubisiensis*, P. and C., *Voironensis*, P. and Lorient.

8.—*Myt. Morrisii*, Sharpe, has probably to be referred to *Brachydontes*, a sub-genus of *Modiola*.

9-13.—*Myt. subsimplex* and *Fittoni*, d'Orb., *æqualis*, Sow., *Montmollini*, P. and C., *Carteroni*, d'Orb., are *Modiolæ*.

14.—*Myt. Salevensis*, Lorient, (Favre, foss de Mont. Salève, pl. C, figs. 20-21, p. 385,) belongs to *Brachydontes*.

15.—*Myt. Desorianus*, Lorient, (ibidem pl. C, figs. 18-19,) resembles more a *Myoconcha* than a *Modiola*.

16.—*Modiola bella*, Sow., is probably a *Crenella*.

17-21.—*Modiola Matronensis*, d'Orb., *Mod. Gillieron*, P. and C., *Mod. undulata*, d'Orb., *Mod. pulcherrima*, Rœm., (? a *Modiolaria*), *Mod. rugosa*, Rœm.

22.—*Myt. densesulcatus*, d'Orb., a ribbed species, but not further characterized.

* Mém. Cour. Acad. Belgique, xxxiv, 1870; Briart et Cornet, Foss. de Bracquegnies, p. 52.

- 23-24.—*Mod. Albensis*, d'Orb., *Mod. Giffreana*, P. and Roux.
 25.—*Myt. Rhodani*, P. and Roux, appears to be a *Lithodomus*.
 26.—*Mod. Mortilleti*, P. and Roux.
 27-29.—*Myt. subfalcatus*, d'Orb.; *Myt. scapularis*, Lam., (= *Myt. Galliennei*,* d'Orb., Guéranger, Album paléont. d. l. Sarthe, 1867, pl. xxii, fig. 1), *Myt. engolimensis*, Coq.
 30-31.—*Mod. Guerangeri* and *ornatissima*, d'Orb., possess the strong ornamentation of *Brachydontes*.
 32.—*Mod. Ligeriensis*, d'Orb.
 33.—*Myt. peregrinus*, d'Orb., is probably a *Septifer*, (see Guéranger, Album paléont. d. l. Sarthe, 1867, pl. xxiii, fig. 7).
 34-36.—*Mod. reversa*,† Sow., *Mod. interrupta*, d'Orb., *Mod. striatocostata*, d'Orb.
 37.—*Myt. clathratus*, d'Arch., may be a *Modiola*, but the solidity of the shell strongly recalls a *Mytilicardia*.
 38-40.—*Mod. semiornata*, *siliqua*,‡ and *inornata*, d'Orb.
 41.—*Modiolaria alternata*, d'Orb.
 42.—*Myt. Chauvinianus*, d'Orb. (= *M. semisulcatus* in Pal. franç.) is most probably a *Crenella*.
 43.—*Myt. dilatatus*, d'Orb., would appear to be a young *Lithodomus*.
 44.—*Myt. pileopsis*, d'Orb., is a *Crenella*.
 45.—*Myt. orbiculatus*, d'Orb., is probably also a *Crenella*; it is stated to be allied to the last named species.
 46.—*Myt. subquadratus*, Math.
 47-54.—*Mod. Dufrenoyi* and *divaricata*, d'Orb., *soluta*, Duj., *Moulinsii*, *Marrotiana*, and *Bourgeoisiana*, d'Orb., *reticulata*, Coq., *Phædra*, d'Orb.
 55.—*Modiola (Brachydontes) ornata*, Münster.
 56.—*Myt. Cottæ*, Rœm., is probably a *Septifer* (vide Ryckholt, Mel. Pal., 1^{re} part., 1852, p. 147).
 57-59.—*Myt. incurvus*, Reuss, *strigilatus* and *anthrakophilus*, Zittel.
 60.—*Myt. striatissimus*, Reuss., ? a *Septifer*.
 61.—*Myt. fissicosta*, Reuss, sp., is based upon an imperfect specimen. If only the beak is broken off, as shown in the figure, the shell must be compared with *Crenella*, but the enlarged figure (7b, given by Zittel l. cit. on pl. xii) is not an exact representation of that drawn in natural size.
 62-64.—*Myt. gryphoides*, 1848,§ *inflatus* and *tegulatus*, Müll., the first and last have the appearance of *Septifers*. Bosquet considers the second named species to be a *Modiola*, and Ryckholt (Mel. paléont., 1^{er} part., 1852, p. 151,) quotes it as a synonym of *M. pileopsis*, d'Orb., which determination is not improbable, for both belong to *Crenella*.
 65.—*Mod. Reussi*, d'Orb., a large form allied to, and probably identical with, Forbes' *Mod. typica*.
 66.—*Mod. radiata*, Münster.
 67.—*Myt. arcaceus*, Gein. This species shows much more affinities to *Mytilicardia* or *Carditamera*, than to any known forms of the MYTILIDÆ.
 68-76.—*Mod. fracta*, Reuss, *concentrica*, Goldf., *sphenoides* and *tetragona*, Reuss, *typica*, Forb., *Oppeli* and *capitata*, Zittel, *flagellifera*, Forbes, *angustissima*, Rss.
 77.—*Modiola ? oviformis*, Müll. If the species belongs to this family, it must be referred to *Crenella*, or to *Septifer*.

* Quoted as *M. Gaillenei* by Pictet and Campiche.

† Mém. Cour. Acad. Belgique, xxxiv, 1870; Briart et Cornet, Foss. de Bracquegnies, p. 53.

‡ Also recorded by Zittel from the Gosau formation in the Austrian Alps; non *Modiola siliqua*, Phil., a recent species.

§ Olim *M. scalaris*, Müller, vide Suppl. Monog. Aachner Kreidef., pl. ii, 1851, p. 68 = *Myt. Mülleri*, d'Orb., 1850 = *Myt. Aquisgranensis*, Ryckholt, Mel. paléont., 1852, 1^{er} part., p. 151.

78.—*Myt. spectabilis*, Müll., (Suppl. Mon. Petræf. Aachener Kreidef., 1859, p. 10, pl. 7, fig. 10). The figured specimen is imperfect; the ornamentation of the shell would indicate a *Septifer*.

79-80.—*Mytilus elegans* and *Modiola flabellum* are described by Schafhäutl from the Bavarian Alps as occurring with fossils of cretaceous age, (Süd-Bayern's Leth. geognost., 1863, pp. 156 and 157).

81-82.—*Modiola angusta*, Römer, (Verst. des N.-D. Oolith., Nachtrag, 1839, p. 33), and *Mod. Queteletiana* are quoted from Neocomien beds by Ryckholt, (Mel. paléont., 1^{er} part., 1852, p. 154).

83-87.—*Mytilus* (? *Septifer*) *Benedenianus*, Ryck., *Myt. Tornacensis*, d'Arch., *Mod. nuda*, Ryck., *Mod.* (? *Septifer*) *Ciplyana* and *Moreniana*, Ryckholt, (Mel. paléont., 1^{er} part., 1852, pp. 147, 150, 152, and 155).

88-89.—*Mod. Mülleri*, Bosq., 1860 (= *Myt. reversus*, Müll., non Sow., sed non *Myt. Mülleri*, d'Orb., 1850 = *M. gryphoides*, Müll.; et non *Myt. Mülleri*, Ryckh., 1852 = *Modiola faba*, Müller), and *Myt. Debeyanus*, Bosquet, (= *Myt. lanceolatus*, Müll., non Sow., vide Staring's Bodem v. Nederland, 2^{de} deel).

90.—*Modiola faba*,* Müll., (Petræf. Aachener Kreideform., pt. i, 1847, p. 36, = *Myt. Mülleri*, Ryckholt, Mel. paléont., 1^{er} part., 1852, p. 150). I have examined a small specimen of this species transmitted to our Museum by Dr. Bosquet, and I think it to be a true *Modiola*, not a *Lithodomus*.

91.—*Myt. Sarthensis*, Guéranger, (Album paléont. d. l. Sarthe, 1867, pl. xxiii, fig. 1), appears to be based upon a fragment of *Modiola flagellifera*, Forbes.

92-93.—*Myt. Drueti* and *M. (?) Coloniae*, Guéranger, l. cit., pl. xxiii, figs. 2 and 8.

94-97.—*Mod. Uralensis*, d'Orb., *vicinialis*, d'Orb., *cuneiformis*, Eichw., and *Fischeriana*, d'Orb., are besides a few others recorded by Eichwald from Neocomien beds of Russia, (Leth. ross., xme livr., 1867, pp. 531 et seq.).

98.—*Modiola indifferens*, Coq., is the only species known from Africa.

99-106.—*Modiola attenuata*, M. and Hayden, *concentrico-costellata*, Rœm., *cretacea*, Conr., *Julia*, Lea, *Meekii*, Ev. and Shum., *ovata*, Gabb, *pedernalis*, Rœm., and *Saffordi*, Gabb, (Meek, Smith. Misc. Coll., No. 177, 1864, p. 11).

107-109.—*Mytilus semiplicatus*†, Rœm., *subarcuatus*, Meek and Hayd., *tenuitesta*, Rœm., (Meek, ibidem).

110-112.—*Crenella elegantula*, Meek and Hayd., *granulato-cancellata*, Rœm., and *C. (Stalagmium) sericea*, Con., (Meek, ibidem).

113-114.—*Mytilus ? humerus*, Con., and *Stalagmium concentricum*, Gabb, are given by Conrad from the so-called lower eocene, or rather cretaceous, rocks of California (Smith. Misc. Coll., No. 200, 1866, p. 5). They are both described by Gabb in the Palæontology of California as coming from cretaceous deposits.

115-117.—*Myt. pauperculus*, *ascia* et *quadratus*, Gabb, Pal. Calif., vol. ii, p. 245.

118-121.—*Modiola Siskyonensis*, *ornata*,‡ *cylindrica* et *major*, Gabb, ibid., pp. 245 and 246.

122.—*Septifer dichotomus*, Gabb, ibid., vol. i, p. 186.

123-124.—*Mod. Socorrina*, d'Orb., (Coq. foss. de Colombie) and *Myt. Araucanus*, d'Orb., (Voy. d'Astrolabe, &c.) are from Chili.

* Non *Mod. faba*, Fabr. apud Reeve, which is a *Crenella*.

† Errore typico "*simplicatus*" apud Meek.

‡ Should *Myt. ornatus*, Münst., prove to be a *Modiola*, Gabb's name will have to be altered.

Myt. eduliformis,* Römer, (Nordd. Kreide., 1841, p. 66), and *M. lævis*, Defr., (Dict. sc. nat., xxxii, p. 151,) are considered as doubtful; neither of them has been figured; the former is a *Mytilus*, about two inches long and one inch high, in form allied to *M. edulis*; the latter may, according to Pictet and Campiche, belong to *Inoceramus mytiloides*.

125-129.—*Modiola typica*, *nitens*, *polygona*, *flagellifera*, *radiatula*, *annectans*, and *Mytilus Arriatooorensis* occur in our South Indian cretaceous deposits. Of these the first and fourth noted species have already been mentioned under previous numbers.

Lithodomus (see Pictet and Camp., l. cit., p. 524).

130-153.—*Lith. prælonga*, *oblonga* and *Archiaci* of d'Orb., *Aubersonensis*, Pict. and C., *amygdaloides* and *avellana*, d'Orb. *obesa*,† *ornata* and *prestensis*, Pict. and Camp., *sub-intermedia*, d'Orb., *traversensis*, P. and C., *rostrata*, *carentonensis*, *sub-orbicularis*, *rugosa*, and *æqualis* of d'Orb., *Coquandi*, Guér., *pyriformis*, d'Orb., *Toucasiana*, d'Orb., *contorta*,‡ Duj. sp., *intermedia*, d'Orb., *cretacea*§ and *hippuritum*, Coq., *Aglæ*, d'Orb.

154.—*L. spathulata*, Gein., would rather seem to be an *Icanotia*, (a sub-genus of *Baroda*, see antea, p. 145), than a *Lithodomus* or *Modiola*.

155-156.—*L. elongata*, Pusch, sp., and *irregularis*, Gein. The last named species does not appear to be a *Lithodomus*, and the next one quoted by Pictet and Campiche must remain as *Modiola faba*, Müll.

157-160.—*L. Cipllyana*, *similis*, *Hannoniæ*, Ryck., and *L. modiolus* (*Cardita modiolus*, Nilsson,) are described by Ryckholt in his Mel. paléont., 1^{er} part., 1852, pp. 127 et seq. The last named species has already (antea p. 194) been cited in the family *GLOSSIDÆ* according to Pictet and Campiche, but Nilsson's original figure rather supports, I think, Ryckholt's generic determination, while the shell figured by Reuss under Nilsson's name could hardly represent the same species, the beaks being shown far too prominent.

161.—*L. Weberi*, Müller, Suppl. Petref. Aachener Kreidef., 1859, p. 19.

162.—*L. alpina*, Zittel, (Denksch. Akad., Wien, 1866, xxv, pt. ii, p. 87,) is from the Gosau-formation.

163-164.—*L. affinis* et *Ripleyana*, Gabb, (Meek in Smiths. Misc. Coll., No. 177, 1864, p. 10,) are from North America.

165.—*L. oviformis*, Gabb, Pal. Calif., vol. i, p. 185.

166.—*L. socialis*, d'Orb., Voy. d'Am. merid., 1842, p. 91.

167.—*L. australis*, Gabb, Proc. Am. Philos. Soc., 1864, p. 194.

168.—*L. cretacea*, Coq., Lynch's Exped., p. 224 (non *idem* Coquand).

169-171.—*Lithod. (Botula) tumidula*, *curta*, and *sub-cylindrica* are from the South Indian cretaceous rocks.

LITHODOMUS, Cuvier, 1817, (see p. 369).

1. LITHODOMUS (? BOTULA) TUMIDULA, Stoliczka, Pl. XXIII, Fig. 16, and Pl. XXXVIII, Fig. 13.

Lith. testa elongate sub-quadrangulari, tumida; postice oblique truncata; umbo-nibus anticis, latis, incurvis; lunula profunda; superficie striis tenuibus incrementi, sulcis nonnullis latioribus intersectis instructa, depressione latiuscula sub-mediana

* D'Orbigny describes (Voy. Am. Merid., 1842, p. 162,) a *Myt. eduliformis* from diluvial or quaternary beds at Montevideo.

† Non *Lith. obesa*, Phil., a recent species.

‡ *L. obtusa* apud d'Orbigny et Guéranger, Album pal. de la Sarthe, 1867.

§ Non *idem* Conrad.

ab umbone utriusque valvulae oblique ad marginem ventralem decurrente, antice et postice sulculis marginata.

Length of shell	:	height	...	...	...	1.50
"	"	:	thickness	...	...	1.33

This is one of the very few species which by its short tumid form, concentric striæ of growth, and the broad incurved beaks, indicate the occurrence of the sub-genus *Botula* in cretaceous deposits. The species is particularly characterized by the sub-median depression (*vide* pl. xxxviii, fig. 13), which extends from the beak of each valve to about the middle of the ventral portion.

Locality.—South-east of Arriallor, in a conglomeratic whitish sandstone; only the figured specimen has been found.

Formation.—Arriallor group.

2. LITHODOMUS CURTA, Stoliczka, Pl. XXIII, Fig. 17.

Lith. testa ovato-cylindracea, antice ac postice sub-truncata, umbonibus anticis, parvulis, superficie concentricè striata.

Length of shell	:	height...	...	...	...	1.8
"	"	:	thickness	...	...	1.82

The single specimen known is not in a very good state of preservation, but the short, almost quite cylindrical, form is so characteristic that the species can be readily distinguished by it. Both the ends are sub-truncate, the anterior slightly convex, the posterior somewhat obliquely obtuse, which form distinguishes the Indian species from *Lith. avellana*, d'Orb. Portions of the surface of shell only indicate the presence of striæ of growth.

Locality.—Odium; found boring in yellowish earthy limestone.

Formation.—Ootatoor group.

3. LITHODOMUS SUB-CYLINDRICA, Stoliczka, Pl. XXIII, Figs. 18-19.

Lith. testa pistilliformi, cylindracea, postice gradatim compressiuscula, ad utramque terminationem sub-rotundata, umbonibus sub-terminalibus, anticis, parvis, incurvis; superficie striis acutis, sulculis nonnullis interpositis, concentricis, tecta.

Length of shell	:	height	...	...	...	2.67
"	"	:	thickness	...	...	2.67 - 2.68

The anterior part of the shell is almost perfectly cylindrical, towards the posterior end the form becomes laterally compressed, and so far agrees very well with that of *Lith. rugosa*, d'Orb., but the Indian species wants the peculiar transverse striation on the ventral side which distinguishes the European fossil.

It could be supposed from the imperfect figure given in the Trans. Geol. Soc., Lond., vii, pl. xvi, fig. 7, that *Lith. sub-cylindrica* is the same shell as Forbes' *Mytilus cypris*, this species having been by European authors also referred to *Lithodomus*; such is, however, not the case, as may be seen by a comparison of the

corrected figure of Forbes' original on our plate xxiii, fig. 12. *Mytilus cypris* I believe to be only a young specimen of *Modiola typica*, Forbes.

Locality.—Odium, in yellowish brown earthy limestone; not common.

Formation.—Ootatoor group.

MODIOLA, Lamarck, 1799, (see p. 370).

1. MODIOLA TYPICA, Forbes, Pl. XXIII, Figs. 12-15.

1846. *Mytilus (Modiolus) typicus* et *cypris*, Forbes, Trans. Geol. Soc., Lond., vii, p. 152, pl. 14, fig. 4, and pl. xvi, fig. 7.

1850. *M. typicus* et *Lithodomus cypris*, d'Orbigny, Prod. II, p. 247.

1866. *Modiola typica*, F., Zittel, Denksch. Akad., Wien, xxv, pt. ii, p. 78, pl. xi, fig. 5.

Mod. testa cuneato-oblonga, paulo arcuata, modice tumida, antice obtusata, postice plus minusve dilatata et ad marginem oblique sub-truncata, ad terminationem postero-inferiorem sub-rotundata; umbonibus sub-anticis, latis, incurvis, contiguis; margine dorsali postico convexo, ventrali medio leviter insinuato; valvis regione ante-mediana ab umbonibus ad marginem ventralem decurrente depressa, costulis et striis incrementi concentricis, in parte posteriore multo crassioribus, in convexitate maxima multiplicatis, et ante medium maximæ elevationis fasciculo obliquo striarum radiantium subtilium decussatis ornatis.

There is a good deal of variation to be observed in the Indian specimens as regards the convexity of their valves. Some are more inflated and less high, others less inflated, and in these specimens the posterior half of the dorsal margin is always more extended, forming an elevated compressed crest. The general form closely approaches that of many fossil and recent species (like *Modiola Phillipinarum*, Hanl.), but the concentric ribs and striæ are much stronger, particularly on the posterior part, and along the ridge of greatest convexity they are much sub-divided. One of the most important distinctive characters consists in a bundle of thin radiating striæ, situated on the anterior declivity of the greatest median convexity of the valves, as already pointed out by Forbes and Zittel. The same character is also to be seen in the European fossil from the Alpine Gosau formation. The fulcra which support the ligament extend over a little more than half the length of the shell and are considerably thickened; the hinge itself is very thin and toothless, as usually in recent *Modiolæ*.

Forbes' *Mytilus cypris*, which d'Orbigny and subsequent authors have referred to the genus *Lithodomus*, appears to me nothing else than a young specimen of *Mod. typica*. I have examined Forbes' original specimen, and after exposing it from the adherent rock, I found that the posterior end is much broader than shown in Forbes' figure; I have, therefore, given another representation of this type. A few radiating striæ are distinctly traceable about the middle of the valves.

Localities.—Anapaudy, Koloture, Alundanapooram, Serdamungalum, &c., mostly in a brownish more or less conglomeratic or earthy rock. The species is also common throughout the Alpine Gosau deposits, the fossils from which mostly correspond with those of the Turonien.

Formation.—Trichinopoly group.

2. MODIOLA NITENS, Forbes, Pl. XXXVIII, Fig. 6.

1846. *Mytilus nitens*, Forbes, Trans. Geol. Soc., Lond., vii, p. 151, pl. xvi, fig. 8—*idem* auctorum.

Mod. testa ovato elongata, tenui; valvis modice sub-convexis, antice angustate rotundatis; postice compressiusculis, sensim dilatatis et ad marginem sub-rotundatis, depressione obliqua paulo profunda ab umbonibus ad marginem antero-ventralem decurrente, umbonibus anticis, latiusculis, depressis, superficie striis incrementi acutis, confertis et tenuibus tecta.

A small species with a thin shell, elongately ovate, being narrowly rounded in front with almost quite terminal beaks and a shallow rather short depression running from them to the ventral margin; the posterior part of the shell widens considerably and becomes very flattened towards the rounded margin. The surface shows only fine, sharp concentric striæ of growth, but no radiating lines, which are so characteristic for *Mod. typica*, from which species the present shell also differs by the smaller convexity of its valves. The same difference applies in a comparison of our species with *M. Oppeli* of Zittel. Forbes' original figure represents a smaller specimen, but the ventral portion should be a little broader at the anterior end, the species being a *Modiola* and not a *Mytilus*.

Locality.—Olapaudy, in a yellowish earthy rock; apparently very rare.

Formation.—Arrialoor group.

3. MODIOLA POLYGONA, d'Orbigny, Pl. XXIII, Figs. 10-11.

1846. *Mytilus (Modiolus) pulcher*, Forbes, Trans. Geol. Soc., Lond., vii, p. 153, pl. xvi, fig. 6, non *idem* Phillips, nec Goldfuss.

1847. *Mytilus polygonus*, d'Orbigny, Voy. Astrolabe Pal., pl. v, figs. 41-42;—*idem* auctorum (non *pulcherrius*, errore typico, in d'Orbigny's Prodrome).

Mod. testa sub-tetragona, regione ab umbonibus ad terminationem postero-inferiorem diagonaliter extensa rotundate carinata, antice sub-rotundata, postice oblique truncata, margine dorsali brevi, recto, ventrali fere recto, vix insinuato, umbonibus sub-terminalibus, anticis, lævibus, valde incurvis, approximatis; superficie striis incrementi tenuibus et alteris radiantibus subtilissimis et confertissimis, vix conspicuis, ornata.

A very marked, obliquely sub-quadrangular and moderately tumid form, each valve being diagonally provided with a rounded ridge, which more or less projects posteriorly and thus slightly alters the form of the shell. At the margins the valves are peculiarly attenuated, forming sharp edges. Besides the striæ of growth which are sharp and very fine, there is almost on the entire surface a very minute radiating striation perceptible under a lens.

Locality.—Pondicherry, in a light bluish grey sandstone; apparently not common.

Formation.—Valudayoor group (?).

4. MODIOLA FLAGELLIFERA, Forbes, Pl. XXIV, Figs. 1-2.

1846. *Mytilus (Modiolus) flagelliferus*, Forbes, Trans. Geol. Soc., Lond., vii, p. 152, pl. xvi, fig. 9.

1850. *Idem*, d'Orb., Prodrome, II, p. 247.

1865. *Modiola flagellifera*, Forb., Zittel, Denksch. Akad., Wien, xxv, pt. ii, p. 82, pl. xii, fig. 2, (cum synonym).

Mod. testa elongata, soleniformi, sub-arcuata, antice rotundate obtusa, postice paulo dilatata et ad terminationem oblique sub-rotundata, sub-compressa, umbonibus anticis, sub-terminalibus, depressis, margine dorsali et ventrali fere parallelis; superficie costulis incrementi flagellatis, antice et prope marginem ventralem multo tenuioribus, ornata.

A peculiar solenoid form, which attains a length of nearly 120 m. m. It is moderately inflated, becoming more compressed, and at the same time very gradually higher posteriorly. The ribs are numerous, thick, more or less subdivided along the most elevated diagonal region of each valve, but on the ventral side they become thinner and are sometimes almost obsolete. Young specimens have comparatively very thin and flattened valves. When the shell surface is very well preserved, it shows a minute punctuation or granulation, which indicates the presence of a slightly rough epidermis in the fresh shell.

Matheron appears to have figured (in 1842) a fragment of this species under the name of *Inoceramus siliqua* from the Dept. of the Rhone. Zittel identified the Gosau form with our Indian, and Bosquet apparently quotes it from Limburg under the name *Modiola flagellifera*, var. *angusta*, (*valvis minoribus, et angustioribus*, Bosquet, Fossil fauna et flora van het Krijt v. Limburg in Staring's Bodem v. Nederland, II^{de} deel).

Thus the species appears to have a large geographical distribution. It belongs to a type which is eminently characteristic of the mesozoic age, and all the species are extremely like each other. I would particularly draw attention to the species described in the above-quoted volume of the London Transactions (p. 193, pl. xxii, figs. 2-3,) from so-called jurassic rocks of South Africa as *M. Bainii*, Sharpe. This species only differs from the Indian shell by very fine transverse striæ near the anterior half of the ventral edge; they are not to be observed on the two specimens of *flagellifera* which I have examined, and Zittel does not notice them in European specimens.

Locality.—Pondicherry, in a bluish grey sandstone; apparently rare. We have no specimens of the species in our collections; the figures I have given are taken from a young shell with open valves and two fragments of a large specimen, the anterior half being the original of Forbes.

Formation.—Valudayoor (? Arrialoor) group.

5. MODIOLA (BRACHYDONTES) RADIATULA, Stoliczka, Pl. XXIII, Figs. 4, 6, 7.

Mod. testa elongato ovata, paulo arcuata, antice angusta, dorsaliter et postice valde dilatata, ad terminationem sub-rotundata, regione ventrali rapide declivi et ad medium insinuata; umbonibus terminalibus, depressis; superficie, in junioribus

speciminibus, costulis et striis radiantibus crispatis seu undulatis et in elevatione diagonali angulatis ornata, in adultis costulae radiantes saepe plus minusve obsoletae, sed striae incrementi multo distinctiores sunt. Cardo denticulo obtuso in utraque valva infra umbones sito instructus.

Shell elongately ovate, slightly arcuate, with terminal depressed beaks, and a very narrow anterior end, the posterior and dorsal portion is greatly dilatated and becomes gradually very flattened, the ventral side is comparatively narrow, precipitous, and slightly incurved at the margin, a shallow depression running as usually from the beaks to the median part of the ventral margin. The hinge has in each valve a distinct obtuse cardinal tooth below the beak, the one in the right valve being a little more remote from the beak than that in the left one.

Young shells when well preserved (see fig. 6, enlarged three times,) have the entire surface covered with more or less undulating radiating ribs, those on the ventral slope being thinner than others; they are on the median convexity of the shell angularly bent. When the surface of the shell is not well preserved, as is often the case in older specimens, the ribs gradually disappear, with the exception of those on the ventral slope, but the concentric striae of growth become instead much more distinct (see fig. 7).

The present species belongs to the type of *Modiola Guerangeri*, d'Orb., but is readily distinguished from it by the more flattened and expanded dorsal portion of the shell. Among recent forms I may quote *M. vexillum*, Reeve, from Australia. These species represent a small group of striated *Modiolae*, for which the name *Brachydontes* may be sub-generically reserved; they have no striae at the lower anterior end. In another small group represented by the next fossil species, the striae are developed on the anterior and posterior end of the shell, while they become obsolete on the ante-median ventral depression. In this latter group also the striae or ribs are usually not angularly bent along the diagonal elevation of the shell, resembling in this respect striated *Mytili*.

Locality.—Neighbourhood of Comarapolliam, in a light coloured sandstone.

Formation.—Arriallor group.

6. MODIOLA ANNECTANS, *Stoliczka*, Pl. XXIII, Figs. 8-9.

Mod. testa elongata, paulo arcuata, angusta, tumida, non carinata; margine dorsali fere uniforme lente curvato, ventrali ante medium insinuato, antice angustissima, postice angustatim sub-rotundata; umbonibus anticis, lente incurvis, depressiusculis; superficie costellis continuis, tenuibus, radiantibus, in depressione ventrali obsoletis, striis incrementi subtilissimis et confertissimis decussatis ornata.

I have already noticed that this species belongs to a small group, represented in a fossil and recent state. The radiating ribs are very fine and decussate by minute striae of growth. The former become obsolete on the ventral depression and are again strongly marked on the anterior end, which is only slightly developed

below the beaks. On the whole, this ornamentation resembles that of *Septifer*, but there is no trace of an internal lamella in the Indian fossil. It differs from *Mod. Cuvieri* (*Myt. lineatus* apud d'Orbigny) by its curved or twisted shape.

Locality.—Vylapaudy, in a whitish sandstone.

Formation.—Arrialoore group.

MYTILUS, *Linné*, 1758, (see p. 371).

1. MYTILUS ARRIALOORENSIS, *Stoliczka*, Pl. XXIII, Figs. 2, 3, 5.

Myt. testa elongato sub-tetragona, umbonibus attenuatis, sub-acutis, terminalibus instructa, compressiuscula; area ligamentali sub-recta, in marginem dorsalem lente curvatum inconspicue transeunte, marg. ventrali paulo insinuato, postico sub-rotundato; regione ventrali angustissima, fere verticaliter declivi; superficie striis incrementi tenuibus et nonnullis sulcis crassioribus notata.

A small rather compressed species of a sub-quadrangular shape, with prominent, attenuated terminal beaks, slightly varying in height, the posterior dorsal edge being a little more extended and curved in the flatter specimens, while in the slightly more tumid ones it is almost straight. The surface only exhibits fine concentric striæ, these being occasionally intersected by stronger marked depressions of growth.

Locality.—Comarapolliam, in a whitish sandstone; not common.

Formation.—Arrialoore group.

XXXIX. *Family*,—PINNIDÆ.

The animals of *Pinna* have the mantle-margins entirely disunited, one pair of long gills and one of moderately elongated triangular palps on each side, the former originating between the palps; the foot is short, conical, grooved below, and with a strong byssal gland; the pedal muscles are well developed, divided into three pairs, one anterior, one median, and one posterior, the two latter consisting of several more or less isolated branches; the posterior adductor is semi-oval or roundish, the anterior much smaller, but well marked; the anus is situated on a prolongation of the rectum, possessing at the side peculiarly elongated valvulæ, the nature of which is as yet unknown.

Shell sub-triangular, equivalve or sub-equivalve, pointed at the beaks, gaping posteriorly, hinge toothless, ligament linear, long, almost internal; muscular scars unequal, the anterior situated at the beak, posterior sub-central, ovate or roundish; pallial impression entire; outer layer of shell fibrous, inner within the pallial line more or less distinctly perlaceous.

The genera to be placed in this family are *Aviculopinna*, *Trichites*, *Pinna*, and *Bryophila*. The two former are known only fossil, the two others recent. A few species of *Pinna* have been recorded from palæozoic rocks, but the forms are somewhat aberrant and may belong to distinct types. True species of *Pinna*

appear, however, in the Trias, and their number increases gradually up to the present date, when they reach their maximum of development.

I have here accepted Philippi's suggestion of separating *Pinna* into a distinct family in preference to classifying it with the *AVICULIDÆ*. As regards the disunited mantle-margins *Pinna* resembles *Avicula*, but the comparatively strong development of the anterior adductor, the origin of the gills between the palps, the development of the median pedal muscles, and the rounded shape of the posterior adductor, agree with the *MYTILIDÆ*. Again, the shell of a *Pinna* resembles a very oblique *Avicula*, in which the anterior ear becomes obsolete, but the manner in which the ligament is attached to the dorsal edge, and its great length, agree much more closely with that of *Mytilus* and *Modiola*, than with *Avicula*. Thus the organisation of the animals, as well as most of the characters of the shells, appear to me to point to a position intermediate between the former and the next family.

1. *Aviculopinna*, Meek, 1864, (Am. Journ. Sc. and Arts, xxxvii, p. 212; Geinitz, Dyas, p. 77). Very elongately sub-trigonal, equivalve, with slightly indicated sub-terminal beaks, the shell being somewhat produced in front of them, posteriorly gaping; hinge line very long, edentulous; type, *Avic. prisca*, Münst., from Permian rocks.

Judging from Münster's figure in Goldfuss' Petr. Germ. the shell of this species appears to be of appreciable thickness, but no account refers to the structure of the shell itself. Its general sub-trigonal form and posterior gape has a very decided relation to *Pinna*, but the beaks are not quite terminal, and the anterior end has almost more the form of a *Modiola* than of an *Avicula*, to which latter genus Geinitz referred the species under the name of *A. pinnaeformis*. If the posterior end were not gaping, but closed, the shell would be better classified in the *MYTILIDÆ*, as suggested by Meek. It also shows a close resemblance to M^cCoy's *Pterinites*, but this is not gaping posteriorly.

2. *Trichites*, Plott, 1676, (Morris and Lycett, Moll. Great Oolite, pt. ii, p. 32; *Pinnigena*, de Luc). Shell generally irregularly sub-quadrate, very thick, fibrous throughout, inequilateral, and mostly inequivalve, often with prominent more or less twisted and terminally obtuse beaks, slightly gaping in front of them; left valve larger, more convex and thicker than the right one, both with variable rugosities on the surface; hinge linear, edentulous, posterior muscular scar sub-central, large, anterior very probably situated at the beaks, as in *Pinna*; type, *Trich. nodosus*, Lycett, from the great Oolite of England. Most of the species known are from jurassic deposits, only one has as yet been recorded from the cretaceous.

3. *Pinna*, Linné, 1758. Sub-trigonal, with terminal, or nearly terminal, produced beaks, the margin being generally slightly indented below the same for the passage of the foot and byssus; posteriorly widely gaping; hinge line straight, edentulous, with a long almost internal ligament, anterior muscular impression small, situated in the beaks, which are often corroded, posterior muscular

scar very large, sub-central; structure of shell fibrous and variously ornamented on the surface, internally pearly within the extent of the pallial line, which is entire; type, *P. nobilis*, Linné. The valves are often split along the median line, which seems to have been more commonly the case in fossil species of the genus, than it is met with in recent shells. The anterior adductor sometimes forms concentric lamellæ in the beaks, their outer surface becoming eroded, and sometimes replaced by a regular chambered vault. This was noted as indicating probably a generic distinction in some fossil species, but is certainly only the result of regular growth and may be often observed also in recent specimens. Species of *Pinna* are rare in palæozoic rocks; they sensibly increase during the jurassic and cretaceous period, become again apparently less numerous in the tertiary epoch, and attain their maximum of development in the present tropical regions, only very few being known from northern seas.

The name *Atrina* has been proposed for *P. saccata*, Linné, which is of a peculiar vitreous structure, and has entire beaks. It barely marks a distinct sub-genus, and it certainly cannot be used to the extent accorded to it by H. and A. Adams.

4. *Bryophila*, Carp., 1864, (Ann. and Mag. Nat. Hist., 3rd ser., xiii, p. 314). Shell like a minute *Pinna*, with pointed beaks; upper margin straight, with a strong internal ligament, anteriorly at the byssal sinus somewhat insinuated, ventrally and posteriorly rounded and gaping; posterior muscular scar sub-central, indistinct; type, *B. setosa*, Carp., from Cape St. Lucas, found between algæ. The animal is stated to be viviparous, and in form "like minute *Pinna*, or a transverse *Margaritophora* without ears, or an *Isognomon* (= *Melina* = *Perna*) without pits." Its length is only 0.13 inch and the width 0.2 inch, but it is said to be adult. The structure of the shell agrees with that of *Pinna*, being fibrous externally, nacreous internally.

LIST OF CRETACEOUS SPECIES.

1. *Trichites Picteti*, Camp., (Mat. p. l. Pal. Suisse, vme ser., 4me part., 1869, p. 76, is the only* well known cretaceous species.

Pinna, see Pictet and Camp., Pal. Suisse, ivme ser., 3me part., p. 536.

2-24.—*P. sulcifera*, Leym., *Gillieronii*, *helvetica*, and *Hombresi*, Pict. and Camp., *Robinaldina*, d'Orb., *gracilis*, Phil., *crassa*, Sow., *gurgitis*, P. and C., *sub-tetragona*, d'Orb., *bicarinata*,† Math., *Moreana*, *Galliennesi*, *Neptuni*, and *Ligeriensis*, d'Orb., *sulcata*, Woodw., *recticostata*, d'Orb., *petasunculus*, Math., *Moulinsii*, d'Orb., *Cotta*, Gein., *cretacea*, Schloth., *quadrangularis*, Goldf., *fenestrata*, Rœm., *nodulosa*, Reuss.

25-28.—*P. abrupta*, *sub-lanceolata*, *sub-cuneata*, and *fugax* are described by Eichwald from various parts of Russia; the three first named species are said to be from Neocomien, the last from Cenomanien deposits, (Leth. Ross., x livr., 1867, p. 545 et seq.).

29-33.—*P. calamitoides*, Shum., *fibrosa*, Meek and H., *laqueata*, Con., *rostriformis*, Mort., and *lingula*, Newb., are noticed from North America by Meek in Smith. Misc. Coll., No. 177, 1864, p. 9.

* *Pinnigena magna*, d'Orb., Prod. II, p. 107, is quite insufficiently characterized. It is quoted from Neocomien beds.

† Zittel unites this species with *cretacea*, which appears to me very probably correct (Denksch. Akad., Wien, xxv, pt. ii, p. 87), and makes some very valuable observations regarding allied species and synonyms.

34.—*P. Brewerii*, Gabb., (Pal. Calif., i, p. 188, and vol. ii, p. 195,) is from California. In vol. ii, p. 268, an undetermined species is noticed by the same author from Mexico.

35.—*P. minuta*, Gabb, Proc. Acad., Phil., 1860, p. 118.

36-39.—*Pinna complanata*, *arata*, *laticostata*, *intumescens* and *consobrina* are from Southern India.

PINNA, *Linné*, 1758, (see p. 382).

1. PINNA COMPLANATA, *Stoliczka*, Pl. XXIV, Figs. 3-4.

1846. *Pinna restituta*, Höningh. apud Forbes, Trans. Geol. Soc., Lond., vii, p. 153, — *non eadem* Höningh. apud Goldf. = *cretacea*, Schloth.

Pinna testa elongato trigona, margine dorsali et ventrali angulo 33° ab apice divergentibus, valvis aut compressiusculis aut lente convexis, medio in parte anteriore longitudinaliter sulcatis, in posteriore fissis, dimidio superiore, aut dorsale, costis 5-6 longitudinalibus, interspaciis duplo latioribus, paulo concavis, separatis, parte inferiore ad medium costis 3-4 similibus et ad marginem ventralem rugis concentricis ornata.

The ornamentation of this species with the slightly prominent and rather distant ribs very much resembles that of the European *Pinna cretacea*, and fragments of it have been considered by Forbes as belonging to this species, but the Indian fossil is much more widely triangular than the European. The valves are along the middle line from the apex entire, and generally slightly grooved; approaching the middle, and further on, they are fissured.

Localities.—Koloture, Anapaudy, Alundanapooram, in brownish sandstone.

Formation.—Trichinopoly group.

2. PINNA ARATA, *Forbes*, Pl. XXIV, Fig. 5, Pl. XXV, Fig. 1, Pl. XXVI, Fig. 5.

1846. *Pinna arata*, Forb., Trans. Geol. Soc., Lond., vii, p. 153, pl. xvi, fig. 10 — *eadem* auctorum.

„ *Pinna decussata*, Goldf., apud Forbes, *ibidem* p. 153.

P. testa lanceolate trigona, margine dorsali cum ventrali angulum fere 25° ad apicem formante, plus minusve inflata, valvis ad medium carinatis et in parte posteriore fissis, dimidio superiore, vel dorsale, utriusque valvæ costis 7-9, in speciminibus adultis postice costulis tenuioribus alternantibus ornato, dimidio inferiore ad medium 3-5-costato, prope marginem ventralem concentrice eleganter striato et plicato.

This species is very closely allied to the European *Pinna decussata*, and some larger fragments of it have been referred by Forbes to that species. The principal distinction between the two is the presence of intermediate ribs on the dorsal or upper halves of each valve in the Indian species. I have not observed these in the true *Pinna decussata*, but if they do occur, there would hardly be sufficient ground for separating the two shells, as the only other character of note consists in the fineness of the striæ of growth crossing the longitudinal ribs in *P. arata*.

Locality.—Anapaudy, Serdamungalum, Koloture, in brownish sandstone.

Formation.—Trichinopoly group.

3. PINNA LATICOSTATA, *Stoliczka*, Pl. XXV, Figs. 2-3, Pl. XXVI, Fig. 4.

P. testa lanceolate trigona, antice tumida, postice complanata, margine dorsali cum ventrali angulum circiter 35°-38° formante, valvis fere uniforme convexis aut convexiusculis, medio non fissuratis, costis 12-14, longitudinalibus, crassis distantibus, 3-4 ad marginem dorsalem approximatis, striis incrementi crassiusculis intersectis ornatis; regione latiuscula inferiori, seu ventrali, rugose plicata et striata.

Shell rather elongately sub-trigonal, tumid near the beaks, and becoming gradually flatter posteriorly. The valves are not fissured along the middle, ornamented with from 12-14 strong distant ribs, crossed by rather distinct somewhat undulating striæ of growth. Three or four of the ribs are along the dorsal margin very closely placed near each other, others reach beyond the middle on the ventral or lower half of each valve, but a rather broad area along the ventral edge exhibits only striæ and somewhat irregular rugosities of growth.

Localities.—Comarapolliam, in a coarse grey sandstone, and Ootatoor, in a light brown limestone.

Formation.—Arrialoor and Ootatoor groups. From the last named group there exists in our collection only one fragment of a large specimen with the shell surface well preserved; it entirely agrees with others from Comarapolliam.

4. PINNA INTUMESCENS, *Stoliczka*, Pl. XXVI, Figs. 2-3.

P. testa elongato trigona, valde inflata, marginibus ad apicem angulum circiter 37° formantibus; valvis lateraliter convexis, antice continuis, uniforme curvatis, postice sub-angulatis, intus furcatis, nonnunquam prope terminationem posteriorem fissuratis; parte superiore valvarum costulis longitudinalibus 6-7 instructa, inferiore fere lævigata, rugis et striis incrementi notata.

A very tumid species with a large pedal opening below the beaks and strongly convex valves. Near the anterior end these are uniformly convex; then follows on the internal side of the shell a deep depression, marked on the cast by an elevated ridge (see fig. 2), and this continues to near the end of the posterior margin, sometimes showing a division between the two halves of each valve.

Localities.—Odium, in earthy limestone.

Formation.—Ootatoor group.

5. PINNA CONSOBRINA, d'Orbigny, Pl. L, Fig. 4.

1847. *Pinna consobrina*, d'Orb., Voy. Astrolabe, Paléont., pl. v, figs. 39-40.

I have given a copy of d'Orbigny's figure merely to complete an account of the shells noted from the South Indian cretaceous deposits. D'Orbigny's figure indicates a species which is very narrow and long; the ornamentation is similar to that of *P. complanata*, but if d'Orbigny's figure is correct and drawn from a good specimen, it cannot be considered as representing the same species. I was not able to find d'Orbigny's original in Paris.

XL. *Family*,—*AVICULIDÆ*.

The mantle margins are in this family entirely open, each half consists of three layers grown together; the inner one is usually thickened towards, and fringed at, the edge itself, with brown pigment cells on the inner side; the gills are narrow, the laterally reflected portions of each pair are (as in *Meleagrina* and many true *Aviculæ*) narrower than the median laminae, and attached to the common base by strong transverse strings; posteriorly the gills are curved or bent upwards and usually quite free at the ends, neither attached to the mantle nor grown together; the palpi are of moderate size, sub-triangular, truncate below, striated on the inner sides; the gills originate below them and not between them as in the *MYTILIDÆ*; foot small, usually somewhat attenuate at the end, below distinctly grooved, and at the base provided with a strong byssal gland. The pedal muscles consist of two branches, an anterior thinner pair and one posterior, much stronger, attached in the convexity of the posterior adductor, which is narrow, elongated, and always more or less curved. The anterior adductor is only represented by a very thin muscle, placed just in front of the base of the labial palps. In *Avicula* this muscle is generally tolerably distinct, in *Melina* (= *Perna*) it is extremely thin, but there is sometimes (in *Melina spathulata* for instance) another thin muscle present just behind the place of attachment of the anterior pedal muscles; this could be regarded as the anterior adductor or at least part of it, for it passes from one side of the mantle direct to the other; in *Vulsella* the anterior adductor is barely traceable, but in *Malleus* it is more distinct.

The shells of the *AVICULIDÆ* are generally inequivalve, the right valve being often a little smaller or less inflated than the left one, and both are generally eared; the anterior ear of the right valve has a byssal sinus, or there is a byssal gape below the beaks indicated by an insinuation of the margins of both valves; the outer layer is scaly, laminar, or partially fibrous, the inner, especially within the pallial impression, nacreous; the hinge line is usually straight, the ligament sub-external, placed either in one groove or in several pits; hinge with small or obsolete teeth; posterior muscular scar sub-central, elongated, usually curved, anterior very slight or obsolete, at the base of the anterior wing; pallial impression entire.

The *AVICULIDÆ* are mostly extinct forms; they have been much more numerous and varied in former geological periods than they are at present. They are already largely represented in palæozoic rocks. It is at present difficult to say in which formation the maximum of development falls, for they are almost equally numerous in each one of them, but certain genera are more or less restricted to certain formations.

The recent species of this family are inhabitants of moderate depths of the sea, and chiefly of the tropical waters, where they mostly occur on coral reefs in one or two fathoms of water. There are about 120 recent species on record, while the number of fossil species is certainly not short of one thousand.

In the arrangement of the genera, I shall here adopt three sub-divisions according to the development and location of the ligament:—

a. *AVICULINÆ*, with *Megambonia*, *Ambonichia*, *Megaptera*, *Monopteria*, *Pterinites*, *Rhynchopterus*, *Posidonomya*, *Halobia*, *Pterinea*, *Pseudo-monotis*, *Casianella*, *Pteroperna*, *Aucella*, *Avicula*.

b. *MELININÆ*, with *Actinodesma*, *Hörnesia*, *Gervillea*, *Inoceramus*, *Anopæa*, *Pulvinites*, *Pernostrea*, *Leproconcha*, *Crenatula*, *Melina*.

c. *VULSELLINÆ*, with *Eligmus*, *Chalmasia*, *Nayadina*, *Dimya*, *Vulsella*, *Malleus*.

a. Sub-family,—*AVICULINÆ*.

Ligament attached to the entire external hinge margin, or placed in a shallow groove near the beak and spreading over the hinge area as it extends posteriorly.

1. *Megambonia*, Hall, 1859, (Pal., New York, iii, 273). Shell sub-ovoid, sub-equivalve, moderately inflated, very inequilateral, with sub-anterior beaks; anterior muscular scar small, distinct, marginal, posterior larger, indistinct; hinge line anteriorly crenulated, posteriorly somewhat expanded, more or less compressed, but not usually distinctly winged; surface marked with lamellar striæ of growth and sometimes also with radiating lines; type, *M. sub-orbicularis*, Hall.

The shells of this palæozoic genus strongly resemble ovoid forms of *Modiolopsis*, with which probably some of the species are generally identical. Hall says that the complete structure of the hinge line is unknown; it is, therefore, impossible to give a good characteristic of the genus. Meek (Am. Journ., Sc. Arts., xxxvii, 215,) observes that some of the species of *Megambonia*, as *M. aviculoides* and *lamellosa*, may possibly belong to a genus allied to, if not identical with, *Pterinia*, "though the typical species appear to belong to the *ARCIDÆ*." ic /

2. *Ambonichia*, Hall, 1843, (Pal. New York, i, 163, and 1859, iii, 269 and 523). Roundly sub-quadrangular, equivalve, moderately inflated, with anterior incurved beaks and a posteriorly extended straight hinge line, anterior side straight, below the beaks slightly insinuated and gaping, posterior truncate; hinge anteriorly below the beaks with a few short oblique, and posteriorly towards the termination of the hinge line also with a few sub-parallel or slightly diverging, rib-like teeth; posterior muscular scar large, sub-central, anterior very small or nearly obsolete; type, *Am. radiata*, Hall, from silurian rocks.

3. *Megaptera*, Meek and Worth., 1866, (Geol. and Pal. of Illinois, vol. iii, 337). Sub-trigonal, sub-equivalve, posteriorly with a very large pointed wing, obtusely convexly angular from the beak to the inferior narrow end, beaks anterior, terminal, incurved, slightly projecting above the hinge line, anterior wing probably obsolete; hinge with a few small anterior teeth below the beak, as in *Ambonichia*: posterior muscular scar large, sub-central, pallial line extending anteriorly up to very near the beak; type, *M. Casei*, M. and W., from lower silurian rocks of Richmond, Indiana.

This form is considered by its authors to be a sub-genus of *Ambonichia*, differing from it by the very strong development of the posterior wing, on which no internal ribs have as yet been observed.

4. *Monopteria*, Meek and Worth., 1866, (Palæont. of Illinois, vol. ii, 339). Obliquely sub-quadrate, sub-equivalve, moderately convex, with a large posterior wing, being below the end generally insinuated, anterior wing obsolete or nearly so, impressed below the beak, without a byssal emargination, but apparently slightly gaping within the lunule; muscular scars very faint; hinge edentulous; ligamental area with a few longitudinal furrows; type, *Monopt. gibbosa*, M. and W., supposed to be from carboniferous rocks of Illinois.

This has been proposed as a sub-genus of *Pterinea*, but it appears to have no internal hinge-ribs which characterize that genus. The authors speak of certain ligamental furrows extending internally, but they are not shown in the figure of the cast which in that part appears perfect.

Meek and Worthen also refer to the relation of *Monopteria* to Hall's *Amphicælia*, which, they say, "was proposed as a sub-genus under *Leptodomus*, to which it is not nearly allied. It evidently belongs to the *AVICULIDÆ*, near *Pterinea*, though apparently generically distinct."

5. *Pterinites*, M^cCoy, 1844, (Carb. Foss. of Ireland, p. 81). Sub-triangular, anteriorly very narrow, becoming gradually wider posteriorly, equivalve, beaks nearly anterior with a small gape below them, hinge line straight, as long as the shell, edentulous, posterior end broadly truncate or very slightly sinuated; type, *Pt. angustus*, M^cCoy, from carboniferous beds. The shells referred to this genus are all of small size; in general shape they strongly resemble *Aviculopinna*, which is, however, stated to be widely gaping posteriorly, like a *Pinna*.

6. *Rhynchopterus*, ~~Meek~~, 1864, (Pal. Calif. i, 31). Obliquely elongated, tumid, anteriorly narrow, with a small acute ear, posterior side uniformly and slightly curved, not distinctly winged; hinge line straight, toothless, slightly thickened; surface covered with concentric striæ only; type, *R. obesus*, Meek, from triassic rocks of California. This genus greatly resembles some of the mesozoic *Aviculæ* with smooth surface, differing from them by the absence of the posterior wing. The shell would also appear to have a close resemblance to *Myalina*.

7. *Posidonomya*, Bronn, 1837. Oblique, ovoid, or rounded, equivalve, very much compressed, thin, hinge line straight, or nearly so, with sub-central slightly prominent beaks, there being a short not emarginated wing on either side of them; surface concentrically sulcated, sometimes very finely radiately striated; type, *P. Becheri*, Bronn, from Devonian deposits. Species of this genus occur in palæozoic and lower and middle mesozoic rocks; none are as yet known from cretaceous, or younger, deposits.

8. *Monotis*, Bronn, 1830, (Bronn's Jahrb. für Mineralogie, &c., &c., i, 284). Obliquely broadly ovate, moderately compressed, equivalve or nearly so, hinge line straight, with the beaks sub-central and slightly projecting, anterior wing rounded in front, posterior oblique, truncate, or slightly insinuated; surface radiately

* Gabb named and described it, not Meek

ribbed; hinge edentulous; muscular scar indistinct; type, *M. salinaria*, Schloth. sp. Species of this genus are as yet only known from triassic rocks of the Alps, Himalayas, New Zealand, and North America.

9. *Halobia*, Bronn, 1830, (emend. Wissm.), (Jahrb. f. Min., &c., &c., i, 284). Semi-circular or semi-oval, with a straight edentulous hinge line and almost central, scarcely prominent, beaks; valves rather compressed, equal, radiately ribbed, the ribs placed close to the hinge line being usually conspicuously thicker than others; wings sub-equal, rounded at their terminations and not emarginated, muscular scars indistinct; type, *H. Lommeli*, Wissm.

The original species described by Bronn is noted as *H. salinarum*, and is based upon an imperfect specimen, apparently restored to a much oblique and inequilateral form. It has the anterior wing conspicuously inflated along the hinge margin and hollow internally.

10. *Pterinea*, Goldf., 1832, (Petræf. Germ., 1834, pl. ii, p. 133). Obliquely oval, inequilateral, moderately tumid, with a long, straight hinge line, produced anteriorly in a shorter, posteriorly in a longer wing, equivalve or sub-equivalve, anteriorly below the wing indented by a byssal opening; hinge-area externally striated, rather broad and thickened, apparently for the purpose of the attachment of the ligament; hinge internally with a few short oblique ribs and posteriorly with a few longer ones, the latter originating below near the apex and extending to the large posterior muscular scar; anterior muscular scar small, deep, situated at the base of the shorter wing close to the apex; type, *Pt. lævis*, Goldfuss. All the known species are palæozoic, chiefly Devonian. The surface is either smooth or radiately striated and ribbed. The hinge ribs are generally placed in connection with the ligament, but from Goldfuss' and Sandberger's figure of the type species, it seems tolerably clear that this explanation is not supported by the internal structure of the valves (*vide* Sandberger's Schichten-syst. von Nassau, &c., pl. xxx). Billings separated a silurian form under the name of *Eopteria* (*E. typica*) on account of a supposed external ligament and equal valves, but these characters would alone not indicate a generic distinction from *Pterinea*.

11. *Pseudo-monotis*, Beyrich, 1862, (Zeitsch. deutsch. Geol. Gesellschaft, vol. xiv, p. 10. *Eumicrotis*, Meek, 1864, Am. Journ., Sc. and Arts, xxxvii, p. 218). Sub-orbicular or roundly oval, the right valve being usually more or less convex, with small, or nearly obsolete, wings and prominent incurved beaks; the left is conspicuously flattened or slightly concave, with barely prominent beaks and with a straight, thickened hinge line, sometimes provided with a flattened tooth-like projection below and an oblique ligamental groove posterior to it, corresponding to a similar groove or pit in the other valve; the anterior end has below the beak a narrow deep byssal incision and a small, sometimes almost obsolete, ear above it. Posterior adductor muscle large, sub-central, anterior minute, at the base of the wing; surface usually covered with radiating ribs; type, *Gryphites speluncaria*, usually referred to *Monotis* or *Avicula*; *Ps. Hawni*, Meek and Hayd., from the Permian

rocks of Kansas is another typical species of this genus. The marked inequality of the valves, the general flatness of the right one, and its narrow deep byssal sinus with a very small anterior ear justify a generic separation from the last named genus, but it seems to me that its characters should be a little enlarged, and that species like *Avicula Münsteri*, Bronn, for which Meek proposes the name *Oxytoma*, should not generically be separated from them (*vide* Check-list cret. and jurass. fossils, Smith. Misc. Coll., No. 177, 1864, p. 39). There is indeed a direct passage from the posteriorly scarcely winged *Pseudomonotis speluncaria* to *Avicula echinata*, Münst., from this again to *A. Münsteri*, Bronn, then to *Avic. costata* and *inaequivalvis* and others, the latter being called typical *Oxytoma* by Meek. The genus is probably represented already in Devonian deposits by such species as *Pterinea bifida*, Sandberger, and it continues up to the close of the cretaceous period.

12. *Cassianella*, Beyrich, 1862, (Zeitsch. d. deutsch. Geol. Gesellschaft, vol. xiv, p. 9; Laube, in Denksch. Akad., Wien, vol. xxv, pt. ii, p. 46, et seq.; *Gryphorhynchus*, Meek, Am. Journ. of Sc. and Arts, 1864, vol. xxxvii, p. 217). Very inequivalve, left valve convex, with strongly incurved beaks, with a small triangular anterior and a shorter blunt or truncate posterior ear, right valve generally equal or slightly smaller, flattened or somewhat convex, with small indistinct ears on either side; hinge line straight; hinge in the left or inflated valve consisting of a few small cross-teeth below the beak and a long rib on either side, parallel to the hinge line; ligament situated in a long groove running from the apex posteriorly and somewhat obliquely to the margin of the hinge line; hinge of right valve apparently similar to that of the left; surface smooth or radiately ribbed; type, *Cass. gryphæata*, Münst., sp. (*Avicula*). The same species has been selected by Meek as the type of his *Gryphorhynchus*, and besides that the author (loc. cit., p. 218,) suggests a sub-generic name *Actinophorus* for the radiately ribbed species like *Cass. decussata*, Münst., but it is clear from Laube's analyses and figures of the hinge of this and other allied species that there is no ground for a further generic or sub-generic separation, and both of Meek's names must, therefore, be considered as synonyms of *Cassianella*.

13. *Pteroperna*, Morr. and Lyc., 1853, (Moll. Great Ool., pt. ii, p. 16). Sub-equivalve, moderately inflated, obliquely oblong; hinge line straight, with a very small anterior wing and a broad shallow insinuation below it, posterior wing long, narrow; ligamental groove sub-external, shallow, long, extending from the beak posteriorly; hinge with numerous small oblique teeth below the umbones and one or two long ribs posteriorly, more or less parallel to the margin of the wing; anterior muscular scar small, close to the anterior ear, posterior elongately ovate, large, excentric; type, *Pt. costulata*, Deslongsch. sp. All the known species are from jurassic rocks.

14. *Aucella*, Keyserling, 1846, (Petschora-land, &c., p. 297). Obliquely elongated, inequivalve, of thin structure, pearly within and with concentric sulcation externally, left valve strongly convex with incurved beaks, with a short posterior and an almost obsolete anterior ear, represented by a slight internal

thickening, margin of shell in front below the beak insinuated; right valve flat or slightly convex near the umbo, with a small indistinct posterior and a still shorter anterior ear, generally a little twisted and separated from the margin below by a deep byssal sinus; hinge line in both valves straight, short, in the right valve usually with a small, blunt tooth; ligament external, linear; muscular scars small, posterior, sub-marginal, anterior placed near the ear and often almost obsolete; type, *A. Pallasii*, Keys. Most of the species of this genus are recorded as occurring in jurassic rocks, but Eichwald more recently considers the beds from which most of these fossils had been obtained as Neocomien. Some species are already known from the Lias, and others even from lower deposits appear to be generically identical with *Aucella*. A few species also occur in cretaceous rocks, but I am not acquainted with any tertiary species which could properly be referred to the genus. Recent species, like *A. smaragdina*, *ala-corvi*, and others, for which I would propose the sub-generic name *Electroma*, appear to represent *Aucella* during the present epoch, but the form of the wing does not agree very well, and the recent species are also less inequivalve.

15. *Avicula*, Klein, 1753, (*Pteria*, Scopoli, 1777). Shell obliquely sub-equivalve, the left valve being very often more convex than the right, pearly within, with the outer surface more or less distinctly lamellated or striated; hinge line straight, and on both sides forming a more or less produced wing, the posterior one being always longer than the anterior, hinge with a single cardinal tooth in each valve, generally stronger in the left one, a byssal sinus is always present under the short wing of the right valve; ligament linear, external or partially sub-internal; posterior muscular scar enlarged, sub-central, anterior close to the ear and more or less obsolete.

15a. The name *Avicula* has been restricted to the very oblique and posteriorly distinctly winged species, the shell has a rather thin structure, and the outer surface is moderately lamellarly striated and ribbed; the type is the Mediterranean *A. hirundo*, Linn.

15b. The oblique, thin, and mostly smooth forms of the type of *A. smaragdina*, Reeve, could be separated under the sub-generic name *Electroma*. They closely resemble true *Aviculæ*, but are more inequivalve, the right valve being somewhat flatter, the hinge line is short, and the posterior wing very short, not separated from the body of the shell. *Electroma* is closely allied to *Aucella*, as already stated.

15c. The third group form the true pearl-oysters of the type of *Avicula margaritifera*, Linn., and for which Lamarck's name *Meleagrina** should be retained. The shells when adult are generally of a solid structure and of a roundly squarish form, the hinge line is long, with a flattened ligamental area externally; the cardinal tooth is sometimes distinct, sometimes almost obsolete; the posterior wing is generally not distinctly separated from the body of the valves, but it is often

* As the older name *Margaritophora* or *Margaritifera* would involve a change in the specific appellation of the type species, it seems preferable to retain that of *Meleagrina*, which is also the best known.

indicated by a posterior insinuation, as in *A. prætexta* or *tegulata*, and those species directly connect *Avicula* and *Meleagrina*, which certainly cannot be separated into two equally valid genera. Young shells of all the three divisions are almost undistinguishable, having the posterior wing very small, or not all developed. Species of *Avicula* occur in all sedimentary formations from the oldest up to the most recent. Many of those from palæozoic rocks are, however, said to belong rather to *Pterinea* and allied genera than to *Avicula*.

b. *Sub-family*,—*MELININÆ*.

Cartilage situated in a number of transverse, marginal, grooves of the hinge line.

16. *Actinodesma*, Sandberger, 1856, (Rhein. Schichtensyst. in Nassau, p. 282). Slightly obliquely and broadly oval, moderately convex, with a long straight hinge line, produced on either side into a narrow wing; hinge with a number of ribs inclined towards the horizontal hinge line on either side of the central area on which they are absent; these ribs are separated by grooves in which the ligament is said to be lodged, being almost quite internal; type, *A. malleiforme*, Sandb., from the Devonian; only one species known.

I do not think that it has been sufficiently established that the grooves alluded to are really ligament- or cartilage-grooves. They rather appear to me to be identical with similar hinge ribs of *Pterinea* and *Gervillea*, and the ligament may have been external and marginal, attached to the thickened margin of the shell which slopes internally, as is, for instance, the case in most species of *Avicula* and particularly in the *Meleagrina* group. If this were the case, the genus had to be transferred to the *AVICULINÆ*.

17. *Hörnesia*, Laube, 1866, (Denksch. Akad., Wien., xxv, pt. ii, p. 52). Obliquely elongated, solid, inequivalve, left valve inflated, with incurved beak, right more or less flattened, hinge line straight, with a short narrow somewhat contorted anterior and a long posterior wing, not separated from the body of the shell, except by a shallow marginal insinuation; ligament situated in several pits externally on the hinge line, one pit being below the beak and reaching rather internally, one is on the anterior and the remainder on the posterior side; hinge in the left valve consisting of a strong oblique tooth under the beak, separated by a pit from a smaller anterior cardinal; in the right valve there is only one strong tooth, besides that there are generally numerous crenulations at the margin of the hinge line in both valves, and one or two oblique sub-marginal ribs posteriorly; muscular scars two, deep, close together, not far from the umbones; type, *H. Joannis-Austriæ*, Klipst., sp., from the Trias. Several of the triassic species of *Gervillea* most likely are referable to this genus, (*vide* Credner in Bronn's Jahrb. für Min., &c., 1851, p. 641, pl. vi).

18. *Gervillea*, Defr., 1820. Very obliquely elongated, generally narrow, sub-equivalve; hinge line straight, with small wings, the anterior being much shorter than the posterior, and neither of them is distinctly separated from the body of

the shell; hinge with several transverse sub-external ligamental pits, anterior and posterior to the umbones with a few long ribs, generally placed obliquely towards the hinge line, and besides often with numerous shorter folds at its margin; type, *G. solenoides*, DeFr. Species of this genus (as restricted) are known from all the mesozoic deposits; they are most numerous probably in the middle jurassic period; only very few species have been recorded from tertiary deposits.

With regard to the genus *Bakewelia* of King, which is by some authors considered to be closely allied to *Avicula*, I have already (p. 335) observed that its classification is somewhat doubtful; it either belongs to the family *ARCIDÆ* where I described it, or it has to be placed in the present family close to *Gervillea*, between this genus and *Hörnesia*.

19. *Inoceramus*, Sow., 1819, (Parkinson in Trans. Geol. Soc., Lond., v, p. 59, and Sowerby, Min. Conch., vol. iii, pl. 305). Roundly oval, or more or less elongated, and often higher than long, equivalve or sub-equivalve, inequilateral, beaks sub-anterior, sometimes with a rudimentary ear in front, below which there is a shallow insinuation; hinge line straight, posteriorly more or less produced, thickened at the margin, and provided with numerous ligamental pits; hinge internally edentulous; external layer of the shell generally very thick, consisting of vertical fibres, internal layer thin, pearly; type, *I. Cuvierianus*, Sow., from cretaceous beds. The genus occurs from the silurian up to the close of the cretaceous period, gradually increasing in number and variety, but does not appear to pass into the tertiary period. The older forms are often found with the outer fibrous layer not preserved, while the pearly layer remains; this is also often the case with species occurring in gault-beds, but those in the upper cretaceous have, on the contrary, the fibrous layer preserved, but not the pearly one. This different mode of preservation is most likely due to the aragonitic or calcitic character of the two shell layers, as pointed out by Sorby and others. The name *Inoceramus* has been by some palæontologists reserved for the mytiloid-shaped species, while *Catillus* was applied to the more inflated and elongated species, like *I. Lamarckianus*, but the one form passes so insensibly into the other, that no generic or sub-generic separation of the two can be retained. Both are characterised by concentric sulcations and more or less regular striæ of growth, sometimes crossing the former. These striæ belong, like in *Iacra* or *Cyclas*, merely to the superficial layer of the shell, which generally consists of a peculiar glassy substance.

The literature of the numerous cretaceous species is partially very confused, and the discrimination of species unsatisfactory. It is to be hoped that the desire expressed by many of possessing a monograph of the genus will soon be satisfied. There are few other fossils more characteristic for the different strata of the cretaceous period than the *Inocerami*.

19a. *Actinoceramus* (Check-list cret., N. A. fossils, Smith. Misc. Coll., No. 177, 1864, p. 32,) has been proposed by Meek for a small group of *Inocerami* of the type *I. sulcatus*, Park. They have a rather short and somewhat oblique hinge line, the left valve is often slightly more globose than the right, and both are

distinguished from other similar forms by the presence of radiating ribs. The fibrous layer appears to be often thinner in *Actinoceramus* than in most of the concentrically sulcated *Inocerami*.

19b. *Volviceramus* I would suggest for the type *I. involutus*, Sow., which has the left valve strongly involute almost like a *Nautilus*, or somewhat resembling a *Gryphæa*, while the right valve is very much smaller, flattened, slightly tumid at the apex, resembling an operculum; the hinge line is curved, conformed to the ovately rounded aperture of the left valve, thickened and provided with numerous ligamental pits, as in other typical species of the genus.

20. *Anopæa*, Eichw., 1861, (Leth. Ross., x^{me} livr., 1867, p. 479). Equivalve, inequilateral, elongated, with the shorter anterior part narrower, beaks close together, with a deep circumscribed lunule in front of them; ligament situated in a number of roundish pits in the straight cardinal margin, which has a rib-like tooth in the left valve below the beak, extending anteriorly for a short distance. Type, *A. lobata*, Auerb. and Frears. Eichwald refers two other species to this genus; all three are from cretaceous deposits; it principally differs from *Inoceramus* by the presence of a deep lunule and by the internal hinge rib (in the left valve).

21. *Pulvinites*, Defr., 1824, (Dict. des. sc. nat., vol. xxxii, p. 316, and vol. xlv, p. 107, cum fig.). Shell rather thin, rounded or oval, moderately inflated, ligament almost internal, situated in seven or eight elongated, sub-parallel or slightly diverging pits; type, *P. Adansonii*, Defr. The geological position of this species is unknown; it is said to have been found at Favrilie, and is either from jurassic or cretaceous beds. D'Orbigny (Pal. franç. crét., vol. iii, p. 522,) does not describe DeFrance's species, as he had no specimen of it. But it is figured in the Dict. d. sc. nat., and reproduced by Chenu in his Manual. This shell singularly recalls the original figure of Conrad's *Tyrodesma*.

D'Orbigny (l. cit.) notices a new species from the Oxfordien of Rochelle under the name of *P. oblonga*. In the Prodrôme (vol. ii, p. 24,) the same author states that the genus is now perfectly known, and that it is an *Anomya* with the hinge of a *Perna*. He does not mention the former Oxfordien species, but calls one from the Corallien of Rochelle, found attached to corals, *P. Rupellensis*. To all appearance the two names have been applied to the same shell. In the Journ. de Conch. for 1853, p. 435, d'Orbigny considers DeFrance's *Pulvinites* to be a '*Perna*' = *Melina*, and proposes for *P. Rupellensis* a new generic name, *Hypotrema*, which, according to him, combines the characters of *Melina* and *Anomya*, having in the lower or larger valve a round opening close to the umbones. If this character of the valve is correctly stated and does not depend upon an accidental removal of an attached portion of the shell, there would be little doubt as to the propriety of the genus *Hypotrema*. But what relation this species, and another called *H. triangularis*, bears to the imperfectly known *Pulvinites* remains yet to be proved. Deshayes (Paris foss., 2nd edit., ii, p. 38,) is disposed to consider both as the same. I never had an opportunity of examining any of these shells, and am, therefore, unable to form an opinion as to the value and relation of the two proposed genera.

Conrad (Journ. Acad. Nat. Sc., Phil., 2nd ser., iii, p. 330, pl. xxxiv, fig. 5,) described a *Pulvinites argentea** from the Mississippi cretaceous beds, which is, I think, the only other species referred to DeFrance's genus.

This is about all we know of the problematic genus *Pulvinites*. It will be interesting to see by further research in what relation these shells stand to the next genus.

22. *Pernostrea*, Mun.-Chalmas, 1864, (Journ. de Conch., iii^{me} ser., tom. iv, pp. 71, et seq., pp. 362 et seq.). Rounded or oval, solid, more or less tumid, inequivalve, the left valve being in adult specimens attached; structure lamellar, resembling that of *Perna*; beaks usually indistinct, hinge area broad, or with age becoming more or less reduced in extent, with numerous (4—8) transverse ligamental grooves or pits, as in *Melina* (= *Perna*); muscular impression rather small, sub-centric, ovately rounded, smaller in the right valve; type, *P. Bachelieri*, d'Orb. The genus forms a connecting link between *Melina* (= *Perna*) and *Ostrea*, differing from the former especially by its sessile habitat, absence of a byssal sinus and strongly excavated muscular scar; from the latter by the presence of separate ligamental grooves. Externally *Pernostrea* is barely distinguishable from *Ostrea*. Munier-Chalmas enumerates six species, all from jurassic deposits. Crosse gave a revision of the genus and established the priority of two species first described by d'Orbigny in his Prodrôme, *P. Bachelieri* and *Luciensis*.

23. *Leproconcha*, Giebel, 1856, (Abhandlung. des Nat. h. Ver. f. Sachsen and Thüringen, i, p. 67). A small roundish shell with the lamellar structure of an *Ostrea*, umbones nearly central, as in *Brachiopoda*, outer surface tubercular, hinge area with 3-4 ligamental (?) grooves.

The above name has been proposed for a small triassic shell which Giebel says comes near to *Plicatula* or *Pulvinites*. If the hinge grooves are ligamental, as they are supposed to be, the classification of the genus would be near *Pulvinites*, but better materials must be examined in order to define the characters of both these problematic genera.

24. *Crenatula*, Lam., 1802. Equivalve, or very nearly so, generally thin, obliquely elongated, sub-oval, smooth or concentrically finely lamellated; beaks obtuse, almost quite anterior, posterior hinge line straight or slightly undulating, with numerous ligamental pits; muscular scars oblong, indistinct; type, *C. avicularis*, Lam. Reeve (Iconica, vol. xi,) describes eight species, all, with one exception, from the Red Sea. The species live in sponges, which accounts for their thin structure. No fossil species of the genus are known, unless some of the irregularly shaped *Melinae* belong to it.

25. *Melina*, Retzius, 1788, (*Isognomon*,† Klein, 1753, *ex parte*; *Perna*, Brug., 1792, non Adanson). Equivalve, or sub-equivalve, irregularly rounded or

* See also Am. Journ. Conchology, III, p. 9.

† I do not think that Klein's name *Isognomon* can safely be accepted. His figure (Ostrac., pl. viii, fig. 15,) may as well represent a variety of some *Malleus*, but on the same plate he figures (fig. 18) a true *Melina* under the name of *Mater perlarum*, and figs. 19 and 20 would appear to represent a *Crenatula*, and are called *Ostræum lave*.

oval, generally higher than long, structure of the outer surface lamellar, beaks anterior, with a small or obsolete anterior ear and a deep byssal sinus below it; hinge line straight, more or less thickened and flattened, with numerous sub-parallel transverse, ligamental grooves, posterior muscular scar large, sub-central, oval or rounded, anterior scar obsolete, or only indicated by a small pit; type, *Mel. ephippium*, Linn. Reeve describes (Icon., xi,) 28 recent species; about six have to be added to his list. Most of them are from the Eastern seas, but a few occur in America. Fossil species are found in all sedimentary deposits, and their number appears gradually to increase up to the present date.

c. Sub-family,—*VULSELLINÆ*.

Ligament lodged in a special, single groove, or pit, extending from the beak internally.

26. *Eligmus*, Deslongch., 1856, (Mém. d. l. Soc., Linn. de Normandie, x, p. 272). Elongately oval, equivalve, tumid, very inequilateral, beaks small, sub-anterior, more or less close together, turned towards the front, with an elongated ligamental pit, lunular* margin in front of the beaks undulating, an irregular gape being produced by a number of incisions on it; muscular scar single, situated on a raised plate, which extends obliquely and anteriorly from below the beaks, outer surface generally radiately ribbed; type, *E. polytypus*, Desl., from jurassic rocks of Normandy. Two other species have been described from the same deposits by the same author, and one, *E. contortus*, by Laube, also from jurassic beds at Balin (Galicia).

The outer lamellar as well as the inner somewhat nacreous layer of the shell of *Eligmus* are rather thin, their structure more resembling that of *Ostrea* than of *Vulsella*, but the other characters relating to equal and free valves, the presence of a gape in front of the beaks, which most probably corresponds to the byssal sinus of other allied genera, and the ligamental groove, appear much better to agree with *Vulsella* than with *Ostrea*.

Munier-Chalmas discussed this question in an able notice published in the Bull. d. l. Soc., Norm., 1862, vol. viii, p. 97, but Deslongchamps (l. cit., p. 111,) does not accept either that author's or Deshayes' views, and maintains his own, that *Eligmus* must be classed with *Ostrea*. As far as I have had opportunity to examine several well-preserved specimens of the Balin and the Normandy *Eligmi*, I believe, that Deslongchamps is correct in rejecting the opinion, that the inner layer of the shell of *Eligmus* has been removed by fossilisation. Neither the thick internal pearly layer, nor the outer, strong, lamellar and partially fibrous layer of *Vulsella*, are developed in *Eligmus* to a large extent, but both appear to be indicated. The differences in the structure of the shells of *Eligmus* and *Vulsella* have their perfect parallel in those of *Crenatula* and *Melina* (= *Perna*), and, I think, therefore, that Deshayes and Munier are justified in classifying the two

* Judging from analogy of other shells, I am rather disposed to regard the longer side of *Eligmus* towards which the beaks are incurved as the anterior one; this view is also supported by the byssal opening in front of it.

former in the same group. I do not, however, see the propriety of establishing a separate family for *Vulsella*, as has been done by H. and A. Adams, especially since the anatomy of the last-named genus and of *Crenatula*, made known by Veillant, does not support this classification.

27. *Chalmasia*, Stol., 1870. Irregularly oblong, longer than high, with prominent obtuse beaks, sub-equivalve, the valves being slightly convex, ligamental groove large, moderately excavated, margin in front of the beaks with several irregular incisions, or internal grooves, similar to those of *Eligmus*, muscular scar sub-central, elongated, and strongly thickened; type, *Vulsella Turonensis*, Duj., (an *concentrica*, Woodw.!) from cretaceous beds. Munier-Chalmas (l. cit., p. 107,) refers this species to *Vulsella*, but in no recent or tertiary species of that genus do any incisions or plications occur in front of the beaks, nor is the muscular scar equally strong in any of them. The shell differs from *Eligmus*, merely by its more compressed form and more centrally placed muscular scar and by its thicker shell; it shows greater affinity to *Pedum*, which has, however, only one incision before the beak, and the ligamental pit strongly produced internally. Beside the type species, two others from cretaceous deposits, *Vulsella aviculoides*, (seu *Larquei*),* and *V. pernoides* of Coquand, probably belong to this genus, but the descriptions are not sufficient to decide the generic identity of those species. A few others will be mentioned in the list of cretaceous *VULSELLINÆ*.

28. *Nayadina*, Mun.-Chalm., 1862, (Bull. Soc. Linn., Normandie, viii, p. 108). Elongately oval, sub-equivalve, tumid, solid, inequilateral, anteriorly narrowly produced, beaks tumid, obtuse, ligamental pit interior, anteriorly produced, a small tooth in the right valve behind the pit corresponding to a depression in the other valve; lunular area long, slightly gaping, with simple thickened margins, posterior side shorter, evenly rounded; muscular scar small, sub-central, semi-lunar, deeply impressed; surface of shell concentrically lamellar; type, *N. Heberti*, from cretaceous deposits. This is the only species as yet known; its form closely approaches that of *Eligmus*, but is readily distinguished from it by its more solid, lamellar structure and the absence of any incisions in front of the beaks.

29. *Dimya*, Rouault, 1850, (Mem. Soc. Géol. de France, 2nd. ser., iii, pt. ii, p. 470). Sub-orbicular, inequivalve, valves flattened,—one of them (the left?) is believed to be adherent,—thin; beaks small, sub-central, internally with a small triangular cartilage pit in each valve; a finely denticulate line issues from the beaks and continues all round near the margin, it was evidently produced by the serrated edges of the mantle; muscular scars two, one anterior and one posterior; the latter is the larger, and both are situated some distance from the margin; pallial line entire; type, *D. Deshayesiana*, Rouault, from eocene beds at Bos. d'Arros, France.

This is a very peculiar shell; its form and structure resembles *Placenta* or *Placuna*, but there are no hinge-teeth present; the two muscular scars separate,

* There is no reason to change the specific name when it has been proved that the species is not an *Ostrea* (vide Coquand Mon. *Ostrea*, terr. cret., p. 195).

however, the genus from all *OSTREACEA*, and as there is an anterior muscular scar indicated in most of the *MYTILACEA*, the classification of the genus may be more correct in this place. If this should not be the case, the only other classification admissible would be near *Myochama* (see p. 60) in the *ANATINIDÆ* (sub-family *PANDORINÆ*).

30. *Vulsella*, Lam., 1799. Sub-equivalve, moderately tumid and solid, higher than long, and sometimes ventrally gaping at the edges, with pointed or incurved more or less approached beaks, which contain internally the ligamental pit, its margins being generally considerably thickened on both sides; muscular scar sub-central, faint above, more marked at its lower edge; outer surface fibro-lamellar, finely scabrous or radiately ribbed; type, *V. lingulata*, Linn. A list of the eighteen recent and about eight tertiary species is given by Munier-Chalmas (Bull. Soc., Normandie, viii, p. 102, et seq.). Species from mesozoic and older deposits are doubtful.

31. *Malleus*, Lam., 1799. Sub-equivalve, narrowly elongated, and often twisted; hinge area long, internally thickened, with distant beaks, more or less produced on either side into a long narrowed wing, ligamental pit extending somewhat internally, a byssal sinus in front and very close to it; muscular scar somewhat irregularly elongated, placed some distance from the cartilage pit; type, *M. vulgaris*, Linn. Reeve (Iconica, xi,) refers thirteen species to this genus. No fossil species are known with sufficient certainty.

LIST OF CRETACEOUS SPECIES OF *AVICULIDÆ*.

- a. *AVICULINÆ*, (vide genus *Avicula*, in Pictet's Mat. Pal. Suiss., V^{me} ser., 4^{me} part., p. 70.
 - 1.—*A. valangiensis*, P. and C.; in form closely resembling *Actinodesma*, Sandb., but apparently without any of the peculiar hinge-ribs which characterize this genus.
 - 2-3.—*A. Carteroni* and *Cottaldina*, d'Orb.
 - 4.—*A. Sowerbyana*, Math., belongs to the sub-genus *Meleagrina*.
 - 5.—*A. Cornueliana*, d'Orb., (= *subradiata*, Desh.) is an *Oxytoma*, a sub-genus of *Pseudomonotis*.
 - 6-8.—*A. Neocomiensis*, Cott., and *Sanctæ-crucis*, Pict. and Camp., and *pectinata*, Sow.
 - 9.—*A. sub-depressa*, d'Orb., (= *depressa*, Forb.) closely resembles *A. anomala*, both of which have the external shape of recent *Crenatulæ*.
 - 10-14.—*A. aptiensis*, *Rauliniana*, *sub-plicata*, *Cenomaniensis* and *interrupta*, d'Orb.
 - 15-16.—*A. anomala*,* Sow., and *Eolis*, d'Orb., have, as already noticed, the form of some recent *Crenatulæ*.
 - 17.—*A. Moutoniana*, d'Orb.
 - 18.—*A. gryphæoides*, Sow., is most likely an *Aucella*.
 - 19.—*A. simulata*, Baily, belongs to *Oxytoma*, a sub-genus of *Pseudomonotis*.
 - 20-22.—*A. Nysa* and *Perigordina*, d'Orb., *Carentonensis*, Coq., are not sufficiently well known; the last may be an *Oxytoma*, judging from the depressed form of its valves.
 - 23.—*A. glabra*, Reuss, is certainly quite a distinct species from *A. anomala*.
 - 24.—*A. Neptuni*, Goldf. I would be more inclined to regard this species as a *Modiola* than an *Avicula*, but I have no specimens to compare.

* Mem. Acad. Belgique, xxxiv, 1870, Briart et Cornet, Fossiles de la meule de Bracquignies, p. 52.

25-43.—*A. caudigera*, Zitt., *raricosta*, Reuss., *cærulescens*, Nilss., *pectiniformis*, Gein., (= *pectinoides*, Reuss, non Rømer), *approximata*,* Schloth. (Goldf.), *Geinitzi*, Reuss, *triloba*, Røem., *semiradiata*, Rss., (non Fisch., 1843), *semiplicata*, Gein., (? a *Pseudomonotis*), *neglecta* and *paucilineata*, Rss., *tenuicostata*, Røem., 1841, (in tabula, = *lineata*, Rømer, 1841, non Goldf., 1838, = *sublineata*, d'Orb., ? a *Pseudomonotis*), *sulcata*, Reuss, *triptera*,* Bronn (Goldf.), *modioliformis*, Müller, (Aachen Kreidef., pt. i, 1847, p. 29, pl. 2, fig. 14), *cineta*, Alth. (Favre, Descript. Moll. foss. de Lemberg, 1869, p. 130), *minuta*, Reuss, *olisoponensis*, Sharpe, and *A. ? Lithuana*, Eichw.

44.—*A. Althii*, Favre, Descript. Moll. foss. de Lemberg, Galicia, 1869, p. 131.

45-46.—*Avicula Beisseli* et *granulosa*, Müller, Suppl. Petræf. Aachener Kreidef., 1859, pp. 9 and 27; the former species closely resembles in shape *Avicula glabra*, Reuss, which is said never to possess radiating ribs, while the ornamentation of *Beisseli* is exactly the same as in *A. raricosta*, Reuss.

47-49.—*Av. laticeps*, *flexuosa*, and *pleuroptychade* are described by Schafhäutl from beds of the Kressenberg which may be cretaceous (see Süd-Bayerns Leth. Geog., 1863, p. 155).

50.—*Avicula clathrata*, Guéranger, (Album, Pal. d. l. Sarthe, 1867, pl. xxii, figs. 11 and 12), very closely allied to *A. anomala*, Sow.; (non *Avic. clathrata*, Sandberger, 1842, a *Pterinea*).

51.—*A. bialata*, Guéranger, l. cit., pl. xxv, fig. 16.

52.—*A. interstriata*, Eichw., (Leth. Ross., xme livr., 1867, p. 506,) is an *Oxytoma*, from the so-called Neocomien beds of Khoroshowo.

53-54.—*A. semiradiata*, Fisch., (= *Russiensis*, d'Orb.), *Volgensis*, d'Orb., are described, beside several other European species, from the cretaceous beds of Russia (Leth. Ross., xme livr., p. 510, et seq.).

55-59.—*Aucella mosquensis*, Buch., *Pallasii*, Keys., *concentrica*, Fisch., *crassicollis*, Keys., and *caucasia*, Buch., are all considered to be Neocomien species by Eichwald (Leth. Ross., xme livr., 1867, p. 519 et seq.)

60-68.—*A. Pomeli* (a *Vulsella*-like species), *mytiloides*, *Serresi*, *gravida* (a *Meleagrina*), *Osmorensis* (very doubtful species), *Delettrei* (? *Meleagrina*), *producta*, *atra* (a *Meleagrina*), and *Tenouklensis*, are described by Coquand from the Province Constantine in Algiers (pp. 215 et seq.).

69-81.—*A. abrupta*, Conr., *convexoplana*, Røem., *cretacea*, Conr., *Haydeni*, Hall and Meek, *iridescens*, Shum., *laripes*, Mort., *linguiformis*, E. and Shum., *nebrascana*, E. and Shum., *pedernalis*, Røem., *petrosa*, Con., *planisulca*, Røem., *subgibbosa*, M. and Hayd., *triangularis*, E. and Shum., are noted from North America, (Smith. Misc. Coll., No. 177, 1864, p. 9).

82-83.—*A. annosa*, Con., and *A. pellucida*, Gabb, are from the so-called lower eocene, or rather cretaceous, deposits (Smith. Misc. Coll., No. 200, 1866, p. 4, and Gabb, Pal. Calif., i, p. 186).

84.—*Meleagrina antiqua*, Gabb, Pal. Calif., ii, p. 192.

85.—*Aucella Piochii*, Gabb, ibidem, p. 194.

86.—*Avicula Samariensis*, Conr., Lynch's Exped. Rep., p. 225, is from Palæstine.

87-91.—*Pseudo-monotis* [*Oxytoma*] *semi-globosa*, Ps. [*Oxyt.*] *fallaciosa*, *Pseudom. inops*, *Aucella parva*, and *Avicula nitida* are from South India.

b. *MELININÆ* (vide *Gervillea*, *Perna*, and *Inoceramus* in Pictet's Mat. p. l. Pal. Suisse, Vme ser., 4me part., p. 91 et seq.).

92-109.—*Gervillea anceps*†, Desh., *allaudiensis*, Math., *Jaccardi*, *tenuicostata*, *Michailensis*, and *digitata*, Pict. and Camp., *alpina*, Pict. and Roux, *aliformis*, Sow., *linguloides*, Forb., *Forbesiana*,

* Considered by Bosquet as *Melina* (= *Perna*, auctorum).

† Vide also Leth. Rossica, xme livr., p. 528.

d'Orb., *magnifica*, Coq., *Fittoni* and *Sobralensis*, Sharpe, *difficilis*, d'Orb., *enigma* and *subaviculoides*, d'Orb., *solenoides*,* DeFr., *Renauxiana*, Math.

110.—*G. silicula*, Müll., Suppl. Pet. Aachener Kreideformation, 1859, p. 9, pl. 7, fig. 8.

111-112.—*G. volucris* and *extenuata*, Eichwald, Leth. Ross, xme livr., 1867, p. 526.

113.—*G. dentata*, Krauss, Nova Acta Acad. Leop.-Car., vol. xxii, pt. ii, p. 458, is from the upper secondary beds on the Zwartkop river of South Africa, regarded by Krauss as cretaceous, but subsequently by other geologists as jurassic.

114.—*G. ala*, Coquand, (Province Const., p. 217,) is from Algiers.

115-118.—*G. ensiformis*, Con., *gregaria*, Shum., *recta* and *subtortuosa*, M. and Hayd., are recorded by Meek from North America, (Smiths. Misc. Coll., No. 177, 1864, p. 9).

119-137.—*Melina Ricordeana*, d'Orb., *Germani*, P. and Camp., *Mulleti*, Desh., *Fittoni* and *Forbesi*, P. and Camp., *Bourgueti*, P. and Renev., *lusitanica*, *polita*, and *fragilis*, Sharpe, *Rauliniana*, d'Orb., *rostrata*, Sow., *lanceolata*, Gein., *Marticensis*, Math., *subspathulata et cretacea*, Reuss, *acuminata et expansa*, Zittel, *Royana*, d'Orb., *Beaumonti*, Coq., (see Pictet and Camp., loc. cit., p. 102).

138-139.—*Avicula approximata*, Schloth. sp., and *A. triptera*, Bronn, (apud Goldfuss), are, as already noticed, transferred by Bosquet to the genus *Melina* (= *Perna*), (see Foss. fauna and flora von Limburg in Staring's Bodem von Nederland, II deel).

140.—*Melina falcata*, Zittel, Denksch. Akad., Wien, xxv, pt. ii, p. 92, pl. 13, fig. 4.

141.—*M. Cenomanensis*, Guéranger, Album Paléont. d. l. Sarthe, 1867, pl. xxv, figs. 9 and 13; allied to the last species.

142-143.—*Mel. gibba*, Eichw., and *Fischeri*, Rouill., are from Neocomien beds of Russia, Lethæa Ross., xme livr., 1867, p. 499.

144.—*Melina grandiosa* is from the South Indian cretaceous rocks.

145-146.—*Inoceramus neocomiensis*, d'Orb., *Jaccardi*, P. and Camp.

147.—*I. sulcatus*, Park., is the type of the sub-genus *Actinoceramus* of Meek.

148-149.—*I. concentricus*, Park., and *Salomoni*, d'Orb.

150.—*I. Coquandianus*, d'Orb., has entirely the form and smoothness of the shell of an *Aucella*. Pictet and Campiche state that there are two pits below the beaks noticeable on cast specimens, but they do not say whether there is one or two in each valve. It is necessary to ascertain the character of these pits, whether they are really ligamental pits, or whether they are produced by hinge-teeth. In *Aucella* there is generally a small blunt tooth below the beak of the flatter, right valve, and it fits below the hinge-margin of the left valve in a special groove. Thus on the cast there would be on the left valve two, on the right one impression produced, and this would almost appear to be indicated in one of Pictet and Campiche's figures of the present species.

151-157.—*I. striatus*,† Mant., *labiatus*,‡ Schloth. (= *problematicus*, Schloth., *mytiloides*, Mant., et auctorum), *latus*,§ Mant. (= *tenuis*, Roem., = *alatus*, Gein., = *concentricus*,§ Gein., = *planus*, Goldf.), *Cripsianus*,§ Mant. (= *Goldfussianus*, and *regularis*,§ *impressus*, d'Orb.), *Lamarcki*, Park., (non d'Orbigny), *Brongniarti*,§ Sow., (non Mant.) (= *cordiformis*, Sow., Eichwald, Leth. Ross., xme livr., pp. 489 and 490), *Cuvierianus*, Brongn.

* Vide Zittel, Denk. Akad., Wien, xxv, pt. ii, p. 91, et Favre, Descript. Moll. foss. de Lemberg, 1869, p. 131, et postea.

† According to Pictet probably identical with *I. undulatus*, Mant., *pictus*, Sow., *concentricus* (ex parte) and *cordiformis*, Goldf., *pernoides*, Math., *tegulatus*, Gein., (non Hagenow). Gümbel (Geog. Beschreib. Ostbay. Grenzgeb., 1868, p. 766), proposes for another peculiar form the name *I. striato-concentricus*.

‡ Probably identical with *I. propinquus*, Münst. An allied species under the latter is described by Eichwald from Khoroshowo (Leth. Ross., x livr., p. 487); it may also belong to *striatus*.

§ Vide Eichwald in Lethæa Rossica, xme livr., 1867, p. 485 et seq.

158.—*I. involutus*, Sow., is the type of the sub-genus *Volviceramus* (see also Eichwald in Leth. Ross., xme livr., p. 489).

159-172.—*I. angulatus* and *cuneiformis*, d'Orb.,* *sublabiatus*, *chamæformis*† and *truncatus*, Coq., *Requieni*, Math., *digitatus*, Sow., *tenuis* and *Websteri*, Mant., *lobatus*,‡ Goldfuss, *annulatus*, Goldf., *tegulatus*, Hag., *Decheni*, Rœm., *nobilis*, Goldf.

173-175.—*I. expansus*,§ *acuteplicatus* and *cardioides*, Schafhäutl, Süd-Bayern's. Leth. Geog., 1863, p. 153, from cretaceous beds of the Kressenberg, Bavaria; the first named species appears to be very closely allied to *I. neocomiensis* as well as to *cuneiformis*, d'Orb.

176.—*I. conicus*, Guéranger, Album paléont. d. l. Sarth., 1867, pl. xxv, fig. 6.

177-179.—*I. ambiguus*, *intermedius* et *Humboldtii*, Eichwald, Leth. Ross., xme livr., 1867, pp. 493-495.

180.—*I. expansus*, Baily, (Quart. Journ. Geol. Soc., Lond., 1855, xi, p. 462), appears hardly to differ from *I. Cripsi*, Mant.

Five other European species are recorded by Coquand from the cretaceous strata of the Province Constantine.

181-183.—*Anopæa lobata*, Auerb. and Frears, *attenuata*, Eichw., *cuneiformis*, d'Orb., are described by Eichwald from so-called Neocomien beds in the neighbourhood of Moscow (Leth. Ross., xme livr., 1867, p. 480).

184.—*Pulvinites Adansonii*, Defr., vide p. 394.

185-222.—*Pulvinites argentea*, Conr., *Inoceramus alveatus*, Mort., *argenteus*, Con., *aviculoides*, Meek, *Barbini*, Mort., *Balchii*, M. and Hayd., *capulus*, Shum., *confertim-annulatus* Rœm., *Conradi*, H. and Meek, *convexus*, Hall and M., *cuneatus* and *exogyroides*, M. and Hayd., *fragilis*, H. and M., *gibbus*, Tuom., *incurvus*, M. and Hayd., *inflatus*, Tuom., *Larouxii*, Marcou, *Mortoni*, M. and Hayd., *Nebrascensis*, Owen, *perovalis*, Conr., *pertenuis*, M. and Hayd., *pseudomytiloides*, Schiel., *proximus*, Tuom., *Sagensis*, Owen, *Salæbrosus*, Tuom., *Simpsoni*, Meek, *subcompressus*, M. and Hayd., *sublævis*, H. and M., *subundatus*, Meek, *tenuilineatus*, H. and M., *tenuirostratus*, M. and Hayd., *texanus*,|| Conr., *triangularis*, Tuom., *undulo-plicatus*, Rœm., *undabundus* and *Vanuxemi*, M. and Hayd., and (*Actinoceramus*) *costellatus*, Conr., have been described from North America, and besides these the European species *Cripsianus*, *latus*, *striatus*, and *labiatus* (= *problematicus*) are quoted, but the identity of the three first named ones is considered doubtful (see Meek Check-list, cret. foss., Smiths. Misc. Coll., No. 177, 1864, pp. 9-10).

223.—*I. peculiaris*, Con., (Am. Journ. Conch., vol. V, p. 43, and vol. VI, p. 76). Mr. Conrad thinks that "this shell should probably be referred to *Cercomya*, Agassiz," (see antea p. 68).

224-225.—*I. Elliotii* et *Whitneyi*, Gabb, Pal. California, II, p. 193.

226.—*Crenatula elegantula*, Meek and Hayden, (Proc. Acad. Nat. Sc., Philadelphia, 1861, p. 441,) is from Nebraska.

227.—*I. Vancouverensis*, Shum., Trans. Acad., St. Louis, I, p. 123, (? errore typico *Vanuxemensis* apud Gabb, Proc. Am. Phil. Soc., viii, p. 186).

228.—*I. Canadensis*, Meek, Assin. Exped., p. 183, from Canada.

229.—*I. Ræmeri*, Karsten, Geol. Verhältnisse von Neu-Granada, pl. 5, fig. 6.

230.—*I. lunatus*, Forb., Quart. Journ. Geol. Soc., Lond., I, p. 179, from Bogota.

231.—*I. plicatus*, d'Orb., Voy. Am. Merid., p. 91, also from Bogota. In form this species closely resembles *I. Requieni*, Math.

* *I. siliqua*, Matheron, Zittel considers as a fragment of *Modiola flagellifera*, Forb., which identification, as far as the figure is concerned, has great probability.

† Also recorded by Coquand from the Santonien of the Province Constantine.

‡ Identical with *I. cardissoides*, *cancellatus*, and *lingua* of Goldfuss.

§ "1846," non *I. expansus*, Baily, 1855.

|| And *I. mytilopsis*, Con., Emory's Rep., p. 153.

232.—*I. aratus*, Con., Lynch's Exped., p. 226, from Palæstine; Fraas considers this to be identical with *I. Lamarcki*.

233-235.—*I. syriacus*, *elevatus*, and *Lynchii* (ibidem) are also noted by Conrad from Palæstine.

236-240.—*I. Cripsianus*, *multiplicatus*, *diversus*, *Geinitzianus*, *labiatus*, and *simplex*, *Gervillea solenoides*, and *Melina valida* occur in the South Indian cretaceous rocks; three of the species are also European and have been already referred to.

c. *VULSELLINÆ*.

241.—*Chalmasia turoniensis*,* (*Vulsella*), Duj., Mem. Soc. Geol. de France, II, p. 228, (see p. 397).

242-243.—*Vulsella aviculoides* and *pernoides*, Coq. (see p. 397).

244.—*Nayadina Heberti*, M.-Chalmas, (see p. 397).

245-246.—*Vulsella falcata*, Münster, (apud Goldf., Petref. Germ., pl. 107, fig. 10), and *V. trigona*, Schafhäutl, (Süd-Bayern's Leth. Geog., 1863, p. 152,) both appear to belong to *Nayadina*. The former species was identified by d'Archiac with one from the eocene beds at Biaritz; this last is an inequivalve shell, while Münster's species is equivalve. Schafhäutl says that it is a cretaceous fossil, and it certainly shows marked relations to *Nayadina Heberti*. D'Orbigny (Prod. II, p. 327,) who regards Münster's and d'Archiac's shells as the same, transfers them to the genus *Ostrea* under the new specific name *O. Hersilia*, d'Orb.

247.—*Vuls. pretiosa*, Eich., (Leth. Ross., xme livr., p. 501,) has the general form of *Nayadina*, but the valves appear to be somewhat unequal and flattened.

PSEUDO-MONOTIS, *Beyrich*, 1862, (see p. 389).

1. PSEUDO-MONOTIS [OXYTOMA] SEMIGLOBOSA, *Stoliczka*, Pl. XXVI, Fig. 1.

Pseudo-m. testa sinistra parva, globosa, tumida, sub-rotundata, paulo obliqua, inæquilaterali, apice incurvo, lato; margine cardinali recto, auricula antica brevi, obtusa, postica (ut videtur) paulo prolongata, angusta, infra distincter insinuata; superficie costis novem radiantibus, lateraliter paulo distantioribus quam in medio, et striis concentricis filiformibus ac confertissimis ornata.

The single valve, though not quite perfect, shows by its very tumid rounded form that it belongs to a species distinct from any other known from cretaceous deposits. The ears appear to be small, like in *Ps. interstriata*, Eichw.; the anterior is short, tumid, not distinctly separated from the valve; the posterior narrow and deeply emarginate below; it seems to have been only a little longer than shown in the figure, its point being broken off. There are nine radiating, rather sharp ribs on the valve, those at the sides diverge slightly more than those in the middle; no intermediate ribs are present, but the surface is very densely covered with filiform striæ of growth.

Locality.—Karapaudy, in a conglomeratic sandstone.

Formation.—Arrialoor group.

* I do not think that the identification of Dujardin's species with Woodward's *Ostrea concentrica* (Geol., Norfolk, 1833, p. 48, pl. vi, fig. 5,) has been satisfactorily proved, but the latter is to all appearance the same as *O. Gehrdensis*, Römer, (Nordd. Kreidef., pl. viii, fig. 1). Coquand (Monog. Ostr. cret., 1869, p. 195,) seems to me to go too far with his identifications of species resembling each other in external characters, while the true identity can only be proved by the study of the internal structure of the valves.

2. PSEUDO-MONOTIS [OXYTOMA] FALLACIOSA, *Stoliczka*, Pl. XXXIII, Fig. 1;
Pl. XXXVIII, Figs. 9-10.

Pseudo-m. valva dextra sub-orbiculata, parte anteriori paulo extensa, depresse convexiuscula, ad marginem fere plana, costulis radiantibus pluribus, antice multo tenuioribus, et striis incrementi confertissimis ornata; margine cardinali brevi, recto, infra umbonem appendiculo, crasso, lato, dentiformi, projiciente, extra striato, intus canaliculato, instructo, antice in auriculam brevissimam, infra profunde insinuatam transeunte. Valva sinistra modice convexa, radiatim multicostata, costis sub-granosis seu rugatis, acutis, fortioribus ac tenuioribus alternantibus; auricula antica indistincta, ad marginem crassula et leviter insinuata; cardine infra apicem fovea parva denti antico adjacente instructo.

This appears to be a larger species than the foregoing; it is more dilated anteriorly than posteriorly, while the reverse is the case in *Ps. semi-globosa*. The posterior wing is not emarginate, but there is in the right valve a very deep and narrow incision below the minute anterior ear, which is intimately connected with a tooth-like, broad appendage below the beak. This appendage has externally a slightly sloping, transversally finely striated face; behind it is a rather deep, sub-triangular depression, apparently for the attachment of the ligament; on the lower side it is deeply canaliculate, posteriorly at the upper end with a round nob, anteriorly with a sharp margin which bounds the byssal incision.

The left valve is moderately convex, of similar form, but apparently larger. The surface has about ten stronger, somewhat rugose, and an equal or larger number of intermediate thinner, ribs. The anterior ear is indistinct, thickened on the internal margin and slightly emarginated. The hinge (see fig. 9, pl. xxxviii,) has below the beak first a small oblique ligamental groove extending posteriorly, then follows a small pit for the reception of the nob, or the appendage, of the left valve; next to the pit is a tooth which fits into the lower groove of the appendage, and then follows a slight insinuation of the thickened hinge margin.

The species closely resembles the European *Pseudo-monotis Cornueliana*, d'Orb., which is, however, more obliquely produced posteriorly.

Locality.—Rajah-Choultry in Strípermatúr district, in a conglomeratic sandstone.

Formation.—Arrialoor group.

3. PSEUDO-MONOTIS (?) INOPS, *Stoliczka*, Pl. XXXVIII, Figs. 7-8.

Pseudo-m. testa sinistra sub-quadrangulati, tenui inequilaterali, modice convexa, antice sub-rotundata, non-conspicue alata, postice oblique truncata, auricula modica ad marginem cardinalem recta, infra terminationem parum emarginata, instructa; umbone projiciente, obtuso, incurvo; superficie striis incrementi tenuibus, liris nonnullis crassioribus intersectis, notata.

Only a few specimens of the right valve have been examined. The general shape, with the almost quite obsolete anterior and moderately elongated, nearly

entire, posterior wing agrees with *Pseudo-monotis*, but the usually characteristic radiating ribs are absent, the surface being marked with thinner and thicker striae of growth. It seems much more probable that the shell belongs to the present genus than to *Aucella*, because this last never has a distinct posterior wing.

Locality.—Rajah-Choultry, in a conglomeratic rock, with the last named species.

Formation.—Arrialore group.

AUCELLA, *Keyserling*, 1846, (see p. 390).

AUCELLA PARVA, *Stoliczka*, Pl. XXXIII, Figs. 2-3.

Auc. testa late et parum oblique ovata, parva, tenui, sub-lævigata, striis incrementi tenuibus induta, valva sinistra convexiore, umbone valde prominente et incurvo instructa; valva dextra planiuscula, umbone tumidulo; utraque postice brevissime et indistincter alata, v. sinistra auricula antica brevi triangulari prædita, infra auriculam emarginata.

A small but typical species of an *Aucella*, with a very thin and smooth shell. The specimens are often very much compressed and deformed by pressure of the surrounding rock.

Locality.—Odium, in a light brown, soft, earthy rock.

Formation.—Ootatoor group.

AVICULA, *Klein*, 1753, (see p. 391).

AVICULA [MELEAGRINA] NITIDA, *Forbes*, Pl. XXIV, Figs. 6—8, and Pl. XXXVIII, Figs. 11-12.

1846. *Avicula nitida*, *Forbes*, Trans. Geol. Soc., Lond., vii, p. 151,—*eadem* auctorum.

Avic. [Meleag.] testa oblique sub-tetragona, equivalvi, moderate tumida, inequilaterali, margine cardinali longo, recto, margine inferiore sub-rotundato, auriculis anticis angustis, brevioribus, tumidulis, ad terminationem sub-acutis, ea valvulae dextræ ad basin vix emarginata; auriculis posticis ab corpore testæ haud distincter separatis, in speciminibus junioribus postice emarginatione modica instructis (vide fig. 12, tab. xxxviii,) in adultis fere rectiuscule truncatis; superficie striis incrementi sub-lamellatis, tenuissimis, distantibus, nonnunquam obsoletis tecta.

Young shells show a small posterior emargination, the hinge-line terminating in a sharp point, but in more fully grown specimens the posterior margin becomes almost quite straight, as is often the case in recent *Melegrinae* of a similar form. The anterior ears are small, tumid, and pointed, that of the right valve barely emarginated below, only a very narrow byssal fissure being present. The surface when well preserved shows very sharp, distant striae of growth, indicating a lamellar

structure, but often they are so far worn down that to the naked eye the surface appears as perfectly smooth.

Locality.—Pondicherry, in a bluish sandstone; Comarapolliam and Veraghoor, in a light coloured sandstone.

Formation.—Arrialoer group.

INOCERAMUS, *Sowerby*, 1822, (see p. 393).

1. INOCERAMUS CRIPSIANUS, MANTELL, Pl. XXVII, Figs. 1—3, and Pl. XXVIII, Fig. 2.

1822. *Inoceramus Cripsii*, Mant., Geol. of Sussex, p. 133, pl. 27, fig. 11; *vide* Zittel in Denksch. Akad., Wien, xxv, pt. ii, p. 95.

In. testa æquivalvi, valde inæquilaterali, elongato-ovata, plus minusve tumida, antice breviter sub-rotundata; postice multo longiore, margine convexe truncato; margine ventrali leviter convexo, dorsali longo, recto, intus incrassato et foveolis numerosis ligamentalibus instructo; umbonibus tumidis, incurvis approximatis; superficie plicis rotundatis, crassis, fere æquidistantibus, et lineis concentricis confertissimis et subtilissimis, nonnunquam paulo undulatis, notata.

The variations which this species exhibits in India are perfectly the same as those observed in the European fossil, of which Zittel gives so many characteristic illustrations. Most common is the var. *typica* of Zittel, of a regular elongated or oblong form and with strongly tumid valves (pl. xxvii, fig. 1). The principal locality where this form occurs is the conglomeratic sandstone about Karapaudy.

A quite similar variety, represented in pl. xxviii, fig. 2, is characterized by a lesser development of the concentric plications, and somewhat smaller and more pointed beaks. This variety is found in whitish sandy beds north-east of Maithal.

The flatter and more rounded variety (var. *regularis*, d'Orb.) occurs in the light grey sandstones west of Arrialoer, and attains here often very large dimensions; specimens of 150 m. m. in length and about 125 m. m. in height are here not uncommon. The same variety also occurs in the fine oolitic rock at Olapaudy; and also the mytiloid variety, with the anterior side very short and obliquely sub-truncate, figured by Zittel as var. *decipiens*, is there associated with other similar forms.

Localities.—Olapaudy, west-east of Arrialoer, Maithal, north-west of Poodoor, north-east and south of Karapaudy, &c.

Formation.—Arrialoer group.

I. Cripsianus is in South India a characteristic fossil of the uppermost series of the cretaceous deposits, the Arrialoer group. In Europe the original form is said to be from the Gault-beds of Sussex, but it has nowhere else been found

in beds so low in the series; on the contrary, it has been shown to be a characteristic fossil of the uppermost series of cretaceous deposits; the determination of the geological horizon of those Sussex beds from which the type was obtained requires, therefore, confirmation.

The species has been recorded by Eichwald from various parts of Russia down into the Crimea; it was known long ago from Galicia (at Lemberg) and from almost all parts of Europe, being common in the Gosau deposits of the Austrian and Bavarian Alps, in the upper beds of the Pläner of Bohemia, Saxony, Braunschweig, Hanover, near Aachen, &c., &c.; it very often here occurs with *Belemnitella mucronata*; equally commonly it is quoted from the Netherlands, France, and Italy. Coquand records it from the Campanien and Santonien in the Province Constantine (Algiers), Beyrich from Tripoli, and various authors from different districts of North America, though Meek in his last Check-list questions the identity of the American form with the European.

2. INOCERAMUS MULTIPLICATUS, *Stoliczka*, Pl. XXVIII, Fig. 1.

In. testa elongate-ovata, tumida, æquivalvi, valde inæquilaterali, umbonibus anticis, sub-angustatis, valde incurvis et approximatis; parte anteriore non prominente, oblique convexiuscule descendente, margine superiore longo, rectiusculo, posteriore late sub-rotundato; superficie costulis concentricis pernumerosis, aut æquidistantibus, aut sulcis angustioribus separatis, ornata.

This species has nearly the same shape as the typical form of *I. Cripsianus*; perhaps a little more oblique, the umbones are somewhat narrower, more distinctly incurved and terminal, the anterior side sloping backward and not projecting in front of them; the surface is covered with very numerous closely set concentric ribs, gradually increasing in strength until near the margin their thickness becomes again somewhat smaller; on the anterior slope they are almost quite obsolete.

Among European species I only know the original figure of *I. undulatus*, Mant., which agrees somewhat in form and ornamentation with our Indian fossil, but Mantell says that the anterior side of this species is strongly projecting and rounded. *I. undulatus*, Mant., has been by different palæontologists identified with *I. striatus*, Mant., but on account of the character just mentioned the identification seems very doubtful, and it is certainly not supported by the ornamentation shown in Mantell's original figures of the specimens described respectively under the two names.

Localities.—Koloture, west of Garudamungalum, west of Karapaudy, Alundana-pooram, in sandstone, not common. The largest specimen is about 100 m. m. long and 60 m. m. high.

Formation.—Trichinopoly group.

3. INOCERAMUS DIVERSUS, *Stoliczka*, Pl. XXVII, Fig. 6.

I. testa sub-quadrangula, ? inæquivalvi (valva dextra modice inflata, sinistra, ut videtur, convexiuscule deplanata), valde inæquilaterali, umbonibus anticis, obtusatis, modice incurvis, margine anteriori et superiori sub-obtusis, posteriori et inferiori leviter curvatis; superficie plicis concentricis, margines versus sub-obsoletis, costis radiantibus, fortioribus, undulatis et partim nodulosis intersectis, ornata.

A very characteristic ornamental species of a sub-quadrangular form, inflated, with the right valve apparently a little more convex, beaks almost quite anterior slightly incurved. Of the left valve only a marginal portion has been seen, which is distinctly flatter than the corresponding part of the other valve, indicating the inequality in the form of both. Whether the same applies to the size of the valves has not been observed. Both are only known from cast specimens, which show a rather coarse concentric plication, the plicæ becoming less distinct toward the margins, being here intersected by stronger, partially nodulous, radiating ribs. Portions of the shell preserved indicated that it was of moderate thickness, and of the usual fibrous structure.

Locality.—Anapady, in a brownish sandstone; apparently rare.

Formation.—Trichinopoly group.

4. INOCERAMUS GEINITZIANUS, *Stoliczka*, pl. XXVII, Figs. 4-5.

I. testa sub-quadrangulari, longiore quam alta, ad medium paululum dilatata, sub-æquivalvi, inflata, antice plus minusve abrupte truncata, regione lunulari deplanata, umbonibus acutis, fere rectiuscule incurvis, anticis; margine superiore recto, postice moderate extenso, modice incrassato, margine posteriore supra paulo insinuato infra convexo, margine inferiore convexiusculo; superficie plicis crassis sub-æqualibus et striis confertis concentricis notata.

This species is closely allied to *I. striatus*, Mant., but it is much less inequivalve, the right valve being apparently only very little, if at all, smaller than the left one; the ribs and striæ also appear to be posteriorly somewhat more distinctly flexuous than in the European *striatus*. Geinitz (*Kieslingswalda*, pl. iii, fig. 12,) figured a right valve of an *Inoceramus* (under the name of *I. concentricus*) which most closely resembles our Indian fossil; it has been perhaps wrongly identified with *I. latus*, Mant., for it shows much more affinities to *striatus* than to *latus*, and if it does not belong to the former species, it may very likely be identical with the Indian one. The species attains a large size; some specimens from Kolature measuring about 160 m. m. in length and up to 130 in greatest height.

Localities.—South-west of Coonum, Puravoy, Ootatoor, Kolakonuttom, Anapady, near Kolature, and Garudamungalum. At the last locality the rock is a brownish grey sandstone with a large number of small shells; at the other localities the specimens occur in a brownish or yellowish highly calcareous and earthy sandstone.

Formations.—Ootatoor and Trichinopoly groups.

5. INOCERAMUS LABIATUS, *Schlotheim*, Pl. XXIX, Fig. 1.

1813. *Ostracites labiatus*, Schlotheim, Bronn's Jahrb., vol. vii, p. 93.
 1820. *Mytilites problematicus*, Schloth., Peträfactenk., i, p. 302.
 1822. *Mytiloides labiatus*, Brogn., Cuv., Oss. foss., pl. 3, fig. 4 in Geol. des env. de Paris.
 1822. *Inoceramus mytiloides*, Mant., Geol. of Sussex, p. 215, pl. 27, fig. 2, pl. 28, fig. 2.
 1823. " " Sowerby, Min. Conch., V, p. 62, pl. 442.
 1827. *Catillus Schlotheimii*, Nilsson, Peträf. Suec., p. 19.
 1836. *Inoceramus mytiloides*, Goldf., Peträf., Germ., II, 188, pl. 113, fig. 4.
 1843. " *problematicus*, d'Orbigny, Pal. franç. terr. crét., III, p. 510, pl. 406.
I. labiatus, problematicus aut mytiloides, auctorum.

I. testa sub-ovata, plus minusve complanata, multo longiore quam alta, umbonibus anticis, paulo prominentibus, depresso incurvis; margine cardinali brevi, fere recto, oblique descendente, margine antico et post-dorsali levissime curvatis, marg. postico sub-rotundato; superficie rugis et plicis concentricis ornata.

Specimens from South India are in every way identical with those from Europe; the variations as to greater or lesser flatness of the valves being the same. The valves of small specimens often appear to be a little more convex than those of large shells, which in India sometimes attain a size of about 200 m. m. in length and about 120 m. m. in height.

Localities.—North-east of Kauray, Odium, Puravoy, Moraviatoor, Ootatoor, Monglepaudy, &c., mostly in a yellowish, highly calcareous and earthy sandstone.

Formation.—Ootatoor group.

In Europe the species has been noticed from the Turon and Cenoman beds of France, from the lowest beds of the upper series of the German Pläner, from the lower Chalk of England, &c., &c. Roemer found it in Texas, and it has since been observed in various parts of the United States of North America.

It is a noticeable and interesting fact that the general geological position of *I. labiatus* in India closely corresponds with that noticed in Europe, where it generally occurs in beds lower than those containing *I. Cripsianus*. The latter exclusively characterizes in India the uppermost series of the cretaceous deposits, the former is equally characteristic for the lowest series,—Ootatoor group,—occurring with *Am. Rotomagensis, rostratus, (= inflatus)*, and other well known European fossils.

6. INOCERAMUS SIMPLEX, *Stoliczka*, Pl. XXVIII, Figs. 3-4.

I. testa sub-ovata, mytiloidea, modice complanata, postice paulo dilatata, umbonibus approximatis, obtusis, margine cardinali postice extenso, oblique descendente, marg. post-dorsali vix curvato, rectiusculo, ventrali leviter insinuato, postico sub-rotundato; superficie plicis concentricis irregularibus, parum distinctis et striis distantibus lamelliformibus notata.

A regular mytiloid form with depressly convex, posteriorly somewhat produced and compressed valves; the ventral side is slightly indented, the posterior very little convex; the hinge-line is straight, posteriorly obliquely produced, provided internally with numerous small ligamental pits. The surface exhibits some indistinct plications and distant lines which mark the extent of the different successive layers of growth.

All the specimens examined have only the fibrous layer of the shell preserved; and it seems probable that the concentric plications are more distinct when the uppermost glassy layer is preserved. In form the species closely resembles some *Melinae* (= *Pernæ*), but it has not the structure of the shell of this genus.

Localities.—South-west of Mulloor (common), Arrialoor, and Olapaudy; (rare); in sandstone.

Formation.—Arrialoor group.

GERVILLEA, *Defrance*, 1820, (see p. 392).

GERVILLEA SOLENOIDES, *Defrance*, Pl. L, Fig. 5.

(*Vide* Zittel in Denksch. Akad., Wien, xxv, pt. ii, p. 91).

There is no specimen of this or any other species of *Gervillea* in our collection, nor in that formerly examined by Prof. Forbes and now deposited in the Museum of the Geological Society of London. D'Orbigny, however, gives a figure of a fragmentary specimen, said to have been received from Pondicherry, and identifies it with the well known European fossil characteristic of the middle and upper series of cretaceous beds. I have given a copy of d'Orbigny's figure in order to complete here the information regarding the species of Pelecypoda recorded from the South Indian cretaceous rocks.

The specimen is rather an imperfect one, but it does not appear to differ in any essential character from the European fossil. It is most probably from the Valudayur beds near Pondicherry.

MELINA, *Retzius*, 1788, (see p. 395).

MELINA VALIDA, *Stoliczka*, Pl. XXII, Fig. 1.

Mel. testa magna, crassa, sub-quadrangula, longa, postice late sub-rotundata; margine cardinali rectiusculo, area cardinali interna lata, canalibus transversis, rectis — in speciminibus adultis circa 25 — instructa; umbonibus moderate projicientibus, angustatis; infra umbones insinuata, valde incrassata et hiantes; valvis modice applanatis striis et lamellis incrementi tectis.

A very large and robust species of an elongately sub-quadrangular shape, with flattened valves and moderately projecting beaks. The hinge area is broad, and in adult shells provided with about 25 straight ligamental canals; its outer, or upper, margin is in perfect specimens almost quite straight. Below the beaks is a moderate insinuation, the edges of the byssal and pedal opening being very much thickened, marked with coarse lamellar striæ of growth, extending internally sometimes to a depth of nearly two inches. Fragments of somewhat larger specimens than the figured one are, below the hinge, nearly one inch thick. The surface of the valves only exhibits concentric striæ and lamellæ of growth, very similar to those of *M. Ricordeana*, d'Orb.

Localities.—Karapaudy, in a brownish conglomeratic sandstone; near Poodoor in a whitish calcareous sandstone.

Formation.—Arrialoor group.

All the specimens examined have only the fibrous layer of the shell preserved; and it seems probable that the concentric plications are more distinct when the uppermost glassy layer is preserved. In form the species closely resembles some *Melinæ* (= *Pernæ*), but it has not the structure of the shell of this genus.

Localities.—South-west of Mulloor (common), Arrialoor, and Olapaudy, (rare); in sandstone.

Formation.—Arrialoor group.

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GERVILLEA SOLENOIDES, *Defrance*, Pl. L, Fig. 5.

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Localities.—Karapaudy, in a brownish conglomeratic sandstone; near Poodoor, in a whitish calcareous sandstone.

Formation.—Arrialoor group.

X. Order,—*OSTREACEA*.

The principal characters of the species belonging to this order consist in the presence of a single, (the posterior), adductor, in the entirely disunited, cirrated, mantle margins, internally sometimes provided with ocelli, and in the small size of the foot. The gills are pectinate, one pair on either side, curved, but usually free, posteriorly; the palps are also two in number on each side, united at the base across the front; the pedal muscles are very slightly developed or obsolete.

The shells are of various shapes, generally somewhat depressed, equivalve or inequivalve, free or attached, in the former case the valves being usually eared at the side of the beaks, while in the latter the ears do not become distinctly developed from the body of the shell; hinge generally edentulous, with an internal or sub-internal ligament; adductor impression single, sub-central, generally more or less completely united with the posterior pedal scar. The outer layers of the shell are laminar, often largely cellular or cavernous; the inner are porcellaneous.

The *OSTREACEA* are, as an order, the only true monomyarian Pelecypoda, and this character, combined with the absence of any siphonal openings, inhalant or exhalant, the small size, or total obliteration, of the foot, as well as the not uncommon sessile habitat, place the order lowest in the system of the Pelecypoda. I have examined a few species of each family, and never found any distinct indication of the anterior adductor. The single one present corresponds solely to the posterior adductor of other Pelecypoda, and cannot, therefore, be taken for a compound of the two, as is occasionally stated in conchological works. The mistake appears to have arisen from the small impression which the pedal muscle sometimes produces; it is only traceable in those species which spin a permanent byssus. The small development of the pedal muscle is a striking peculiarity in the anatomy of the *OSTREACEA*, as compared with the *MYTILACEA*. In the former, there is only a single pedal muscle present, becoming confluent with the upper part of the adductor in the free, not byssiferous, species; in the free byssiferous species it divides into two very short branches at the posterior end, and is attached above and quite close to the adductor; in the sessile forms it becomes quite obsolete. The anterior pair of pedal muscles is never developed; there is, however, occasionally a small muscle present attaching the posterior end of the palps and the base of the branchia next to the adductor. The sexes are united in some, distinct in others. The mantle often forms duplicatures on the internal side, apparently for the purpose of hatching eggs.

The order can be conveniently sub-divided into six families: *RADULIDÆ*, *PECTINIDÆ*, *SPONDYLIDÆ*, *OSTREIDÆ*, *PLACUNIDÆ*, and *ANOMIIDÆ*. Of these, the *RADULIDÆ* may be considered as the highest family, because they are always free and equivalve.

In a geological point of view, the *OSTREACEA* are a very important group of Pelecypoda, a great many species being recorded among the fossils characteristic of various formations; and taking the order as a whole, by far the greater number of species is extinct, as might be expected. When we estimate

the number of recent species at somewhat near 500, that of the fossil is certainly four times as large. However, the different families are not equally represented in the different formations. The *RADULIDÆ*, *ANOMIIDÆ*, and *PECTINIDÆ* already occur in palæozoic strata; but only the species of the last are numerous, represented by several peculiar types which again soon disappear. The *SPONDYLIDÆ* and *OSTREIDÆ* are only known with sufficient certainty since the beginning of the mesozoic epoch. It is not improbable that most of the families have the maximum of their development during the cretaceous period: with the *RADULIDÆ* and *OSTREIDÆ* it is certain, with the *PECTINIDÆ* and *SPONDYLIDÆ* probable, while the species of fossil *ANOMIIDÆ* are as yet few, and still fewer are the *PLACUNIDÆ*.

XLI. Family,—*RADULIDÆ*.

The mantle margins of the animal of *Radula* are entirely disunited, thickened, provided with several irregular rows of elongated filaments of various sizes; the inner edge of the mantle is thin, produced all round, closed for some distance over the oral and less so over the anal region; on the internal side of each mantle leaf it forms an open loose bag in which the gills are placed. These are narrowly attached at the antero-inferior margin of the adductor, are of an elongately oval shape and loosely suspended in the bag; they consist of very fine, rather distant fillets. The palps are transversally elongated, short, internally striated; the two leaves of each pair are anteriorly united for a great part, and the pairs themselves are again united at the base across the front. The body is usually rather large, ovately elongated; the foot anterior, placed some distance below the palps, elongated, sub-cylindrical, slightly dilated at the end, grooved above, and with a byssal gland at the base; the pedal muscles are not developed; the foot only appears as a narrowly produced thickening of the skin of the body. The adductor is placed rather posteriorly, not far from the hinge; it is of an oval shape; the rectum is grown to the posterior side of the adductor and has a short, free, tubular termination.

I have examined the animals of two species, one of *Radula*, as restricted, and the other of the sub-genus *Mantellum*: they are quite similar. The large development of the internal thin layer of the mantle, forming an open bag, appears to be destined for hatching the eggs, and is no doubt also an important organ for retaining water while swimming. There is a distinct byssal gland present, being able to spin a byssus, if required, but its secretion does not appear to be permanent.

The shells are obliquely oval, inflated or compressed, gaping or closed, always equivalve and free; hinge margin on each side produced into short, unequal ears; hinge area more or less developed, with a median triangular pit for the attachment of a partially internal ligament, sometimes with a byssal and pedal gape below the anterior ears.

By far the greatest number of the species of *RADULIDÆ* is extinct. Those belonging to *Limea* first occur in the Trias and continue up to the present time, but in very small numbers; the species of *Radula* are, on the contrary, already

met with in palæozoic beds, though also rarely. In the Trias, the number increases considerably, rising to about 30 or 40; the species belonging mostly to *Radula* (as restricted) and to *Plagiostoma*. From the jurassic period there must be about 120 species known: *Plagiostoma* is very largely represented; next comes *Radula*, then *Limatula* and the peculiar *Ctenostreon*. From cretaceous rocks there are at present about 204 species on record, and the number is still rapidly increasing with the examination of the various horizons of this period, in which the family evidently attained its greatest development. All the sub-generic divisions are found there represented; and very probably when our materials have been improved, it will be found convenient to arrange the costate forms, now generally referred to *Radula*, into several sub-genera. From tertiary beds there are barely more than 60 species known, and in the present time, this number has been reduced nearly by one-half. Of *Limea* there are only four species known, but it is not improbable that a few of those described as *Radulæ* will be shown to belong to *Limea*. I will note some of those species.

In comparing the cretaceous species known from the so-called Old Continent with those of the New Continent, it is noteworthy to observe that the present geographical distribution of the recent forms was already indicated at that early date, or perhaps it was even more marked. Out of the 204 species of cretaceous *Radula* and its sub-genera, there are only twelve which have been found in America.

1. *Radula*, Klein, 1753, (Ostrac., p. 135, pl. ix, fig. 34, *Lima*, Brug., 1792). Shell obliquely sub-ovate, generally moderately inflated, equivalve, radiately ribbed or striated; beaks prominent, pointed, more or less distant from each other; hinge-line with unequal ears on either side, generally somewhat sloping from the beaks, with a small triangular area between them and a sub-median cartilage pit in it, extending somewhat internally; muscular scar sub-centric, pallial line entire, both faint; type, *Radula lima*, Linn., a recent species which already occurs in the miocene strata of the Vienna basin. I can see no essential difference between the recent Mediterranean forms, those from the Red Sea and those from the Nicobar Islands, where I collected the species in great numbers.

The recent species are few and rather general in their distribution, though none of them are very common shells. Several useful sub-genera have been distinguished by H. and A. Adams in their "Genera of recent Mollusca." I have only little to add to these.

1a. The name *Radula* must be restricted for the type species *R. lima*, Linné, which is probably the same which Klein quotes as *Rumphiana*, and which occurs at the Nicobars. The shell is rather strongly radiately ribbed, oblique, moderately compressed, the anterior or concave side having a comparatively narrow gape. The ribs are either smooth, or concentrically striated, or squamose. The cretaceous period contains a large number of species belonging to this division, but some of them are rather of a peculiarly rounded shape, with inflated valves, approaching the next sub-genus.

1b. *Mantellum*, Bolten (1798), are called the narrow oblique forms, with thin, often almost hyaline, radiately ribbed, inflated valves, with very distant beaks, and a wide anterior gape; the type is *Radula hians*, Gm. (*Ostrea*).

1c. *Acesta*, H. and A. Adams, 1855, was proposed for the recent *R. excavata*, Chem., an elongated, moderately compressed shell, with rather fine radiating ribs, oblique in form, with the anterior ear very small, the posterior much larger, and with the cartilage pit situated obliquely under beak, being excentric. Species of this sub-genus already occur in the cretaceous period.

1d. *Plagiostoma*, Sow., 1812, (Min. Conch., i, p. 175), must be reserved for the species of the type of the liassic *Pl. gigantea*, for which it was originally proposed. It is a very well marked group of fossil, especially mesozoic, *Radulæ*, of a semi-ovate or sub-triangular shape, with nearly smooth or finely radiately striated surface, the striæ being generally only conspicuous at the sides of the valves, but nearly obsolete in the middle; the ears are thick and unequal, the anterior being smaller, and the cartilage pit is oblique and triangular, generally very deep.

1e. *Limatula* has been proposed, 1839, by Searles Wood for a characteristic group of species of the type of *R. sub-auriculata*, Mont., the shells being narrow, tumid, and almost equilateral, very little oblique; and the radiating striæ or ribs are only developed in the median portion of the valves. The type is well marked already during the jurassic, and the species are especially numerous during the cretaceous period.

1f. *Ctenoides* was used, 1753, by Klein for the almost equilateral, slightly oblique, long, species of the type of *Radula scabra*, Born. The shells are hardly gaping in front, the anterior margin almost straight, instead of being concave, and the radiating ribs are numerous and scabrous. Species of this sub-genus also occur in cretaceous rocks.

1g. *Ctenostreon*, Eichw., 1867, (Leth. Ross., x^{me} livr., p. 455). Sub-æquivalve, with strong radiating ribs, the large anterior margin above, or at the side, with a distinct byssal sinus; type, *Ct. distans*, Eichw., l. cit., p. 456, from the Neocomien of Russia. This is another well marked group of generally large and strongly ribbed *Radulæ*, the shell of which is often irregular, like that of some *Hinnites*; when adult, it is characterised by the presence of a deep insinuation in the anterior ear for the byssus, but in young shells this insinuation is hardly more developed than in other allied forms. *Lima proboscidea* of Sowerby from jurassic deposits is another species of the sub-genus, and there are a few other mesozoic forms which may be referred to it.

2. *Limea*, Bronn, 1831, (Italien's Tertiærbgeb., p. 115). Shell obliquely roundly ovate, generally considerably inflated, radiately ribbed, slightly gaping in front; beaks prominent; hinge-line slightly sloping and eared on both sides; cardinal margin internally with numerous teeth, divided in the middle by a triangular cartilage pit; muscular scar faint, sub-central; type, *Ostrea strigillata*, Brocc., from tertiary deposits of Italy. Fossil species are known from the Trias in all

the successive formations, but they are always rare. One recent representant, *L. Sarssii*, Lovén, has been found in the Norwegian Sea. Fossil species occur through all the mesozoic and tertiary deposits from the Trias, but are always scarce.

LIST OF CRETACEOUS SPECIES OF *RADULIDÆ*.

Radula and its sub-genera.

For reference of the first 159 species quoted, see "Cat. des *Lima* cretacées connues," Pictet and Campiche, (Paléont. Suisse, vme ser., 4^{me} partie, p. 161, et seq.). In the present list I shall add the sub-generic names in parentheses.

a. From the Neocomien (incl. Urgonien et Valangien) of Europe.

1-10.—*Radula Carteroniana*, d'Orb., *R. [Acesta] Dubisiensis*, P. and C., *R. [Acesta] Orbignyana*, Math., *R. Villersensis*, P. and C., *R. longa et plana*, Rœm., *R. [Plagiostoma] neocomiensis*, d'Orb., *R. [Plagiostoma] capillaris*, P. and C., *R. [Acesta] undata*, Desh., *R. [Acesta] Lorioli*, P. and C.

11-20.—*R. subrigida*, Rœm., *R. stricta*, Rœm., *R. Gillieron*, Lor., *R. [Plagiostoma] Berriasensis*, Pict., *R. [Plagiostoma] Dumasi*, Pict., *R. [Plagiostoma] Bolina*, d'Orb., *R. [? Acesta] Varapensis*, Loriol, *R. [? Ctenoides] Essertensis*, Loriol, *R. [? Acesta] Sanctæ-crucis*, P. and C., *R. Arzierensis*, Lor.

21-30.—*R. [? Plagiostoma] Robinaldina*, d'Orb., *R. [Plagiostoma] Aubersonensis*, P. and C., *R. [Plagiostoma] Vigneulensis*, P. and C., *R. [Ctenostreon] pseudo-proboscidea*, Lor., *R. Etallon*, P. and C., *R. Royeriana*, d'Orb., *R. Germani*, P. and C., *R. gemmata*, P. and C., *R. sculpta*, P. and C., *R. Nicoleti*, P. and C.

31-38.—*R. Moreana*, d'Orb., *R. exquisita*, Lor., *R. Rusillensis*, P. and C., *R. Galloprovincialis* and *Massiliensis*, Math., *R. [Limatula] Tombeckiana*, and *R. [Limatula] Dupiniana*, d'Orb., *R. [Limatula] semicostata*, Rœm.

b. From the etage Aptien and Gault of Europe.

39-40.—*R. Cottaldina*, d'Orb., *R. expansa*, Forb.

41-50.—*R. lingua*, Forb., *R. [Limatula] semisulcata*, Sow.,* *R. [Plagiostoma] hispanica*, Coq., *R. [? Acesta] Eucharis*, Coq., *R. [Acesta] Rauliniana*, d'Orb., *R. [Acesta] Vraconensis*, P. and C., *R. Itieriana*, P. and Roux, *R. depressicostata*, P. and C., *R. Ricordeana*, Cott., *R. alpina*, P. and Roux.

51-55.—*R. Sabaudiana*, P. and R., *R. Saxoneti*, P. and R., *R. [Plagiostoma] albensis*, d'Orb., *R. [Plagiostoma] montana*, P. and R., *R. [? Plagiostoma] Rhodaniana*,† d'Orb.

c. From middle and upper cretaceous beds of Europe.

56-60.—*R. [? Ctenoides] subovalis*, Sow. (Trans. Geol. Soc., Lond., 2nd ser., iv, pl. 17, fig. 21), *R. [Acesta] clypeiformis*, d'Orb., *R. [Plagiostoma] simplex*, d'Orb., *R. [Ctenoides] rapa*, d'Orb., *R. [Ctenoides] ? frondosa*, Duj., (*tecta*, d'Orb.).

61-70.—*R. Reichenbachii*, Gein., *R. Galliennei*, d'Orb., *R. Astieriana*, d'Orb., *R. elongata*, Sow., *R. Farrigdonensis*, Sharpe, *R. intermedia*, d'Orb., *R. Cenomanensis*, d'Orb., *R. [Acesta] ornata*, d'Orb., *R. [Plagiostoma] semi-ornata*, d'Orb., *R. [Acesta] sub-consobrina*, d'Orb.

* Nilsson's and Sowerby's figures under the same name do not represent the same species.

† This may prove to be a *Limea*.

71-80.—*R. [Limatula] sub-æquilateralis*, d'Orb., *R. [Acesta] sub-abrupta*, d'Orb., *R. Varusensis*, d'Orb.,* *R. Moutoniana*, d'Orb., *R. Eolis*, d'Orb., *R. Calypso*, d'Orb., *R. [? Acesta] pennata*, d'Arch., *R. [Plagiostoma] rectangularis*, d'Arch., *R. resecta*, d'Arch., *R. Renauxiana*, Math.

81-90.—*R. Boreani*, Coq., *R. [? Acesta] aspera*, Mant., *R. [Ctenoides] granosa*, Sow., *R. Rotomagensis*, d'Orb., *R. ?.....[Ctenoides] tecta*, Goldf., *R. plicatilis*, Duj., *R. ?... (multicostata†* apud d'Orb.), *R. [? Ctenoides] Bangasiana*, d'Orb., *R. Coniacensis*, d'Orb., *R. Rambaudi*, Coq.

91-100.—*R. Trigeri*, Coq., *R. Marticensis*, Math., *R. Dujardini*, Desh., *R. pulchella*, d'Orb., *R. granulata*, Nilss., *R. [Plagiostoma] Santonensis*, d'Orb., *R. intercostata*, Duj., *R. Ligeris*, Duj., *R. Bourgeoisiana*, d'Orb., *R. [Plagiostoma] maxima*, d'Arch.

101-110.—*R. Rochebruni*, Coq., *R. Arnaudi*, Coq., *R. ? (aspera, d'Orb.)*, *R. Dutempleana*, d'Orb., *R. pectinata*, d'Orb.,‡ *R. [Ctenoides] divaricata*, Duj., *R. [Ctenoides] obsoleta*, Duj., *R. elegans*, Nilss., *R. [Limatula] elegantula*, d'Orb., *R. [? Plagiostoma] Toucasiana*, d'Orb.

111-120.—*R. [Plagiostoma] Hoperi*,§ (includ. *Mantelli*, Brong. et d'Orb., *P. punctatum*, Nilss., and *Goldfussi*, Hag.), *R. [Plagiostoma] Sowerbyi*, Geinitz, (*Quadersandst.*, p. 192), *R. Marrotiana*, d'Orb., *R. [Plagiostoma] difficilis*, d'Orb., *R. truncata*, Goldf., *R. Baylei*, Coq., *R. [Plagiostoma] ficoides*, Coq., *R. [Plagiostoma] inornata*, Coq., *R. dissimilis*, Coq., *R. [? Plagiostoma] tumida*.||

121-130.—*R. [Plagiostoma] Paqueroni*, Coq., *R. Carolina*, d'Orb., *R. [Ctenoides] tecta*, Goldf., *R. æquicostata*, Gein., *R. pseudocardium*, Reuss, *R. [Ctenoides] amygdaloides*, Rss., *R. laticostata*, Rœm., *R. [Limatula] septemcostata*, Rss., (*R. Reussi*, d'Orb.),¶ *R. multicostata*,** Geinitz.

131-140.—*R. carinata*, Münst., *R. [? Acesta] subplana*, d'Orb., (= *Lima plana*, Reuss); *R. undulata*,†† Rss., *R. [Plagiostoma] lævissima*, Rss., *R. [Plagiostoma] decalvata*, Rss., *R. interstriata*, Gein., *R. [Limatula] paucicostata*, Rss., *R. [Limatula] decussata*, Münst., *R. [? Acesta] dichotoma*, Rss., *R. minuta*, Goldfuss.

141-150.—*R. ovata*, Nilss., *R. canalifera*, (including *multistriata*, Gein., according to Gümbel, Münch. Akad. Abhand., x, p. 560), *R. squamifera*, et *muricata*, Goldf., *R. Forchhammeri*, *Dunkeri* et *Geinitzi*, Hagenow, *R. denticulata* et *pusilla*, Nilsson, *R. [Plagiostoma] striatissima*, Reuss.

151-160.—*R. [Limatula] angusta*, Reuss, *R. rarispina*, Zittel, *R. [Plagiostoma] Hörnesi* et *Haidingeri*, Zitt., *R. Pichleri*, Zitt., *R. Bronni*, Alth., *R. inflata*‡‡ et *dentata*, (1851)‡‡ Müller, *R. [Ctenoides] nux*, Gümbel; *R. [? Ctenoides] nobilis*, Goldf., (*Inoceramus idem*, Petræf. Germ., ii, pl. 113, fig. 3), stated by Bosquet (Staring's *Bodem v. Nederland*, ii deel,) to be a *Radula*.

161-163.—*R. [Plagiostoma] nuda*, *R. Sarthensis*, and *R. [Acesta] lineolata* are figured by Guéranger in his *Album paléont. de la Sarthe, &c.*, 1867, pl. xxiii, fig. 25, and pl. xxiv, figs. 8 and 15.

* Stated to be allied to *R. [Ctenostreon] proboscidea*.

† The French species is stated to be different from *R. multicostata*, Geinitz, (1839), non *R. multicostata*, Sow. a recent species.

‡ Quoted as "*pectita*" by Gabb and by Pictet and Campiche.

§ A similar species is noticed by Kunth from Lower Silesia (*Zeitsch. der Deutsch. Geol. Gesellsch.*, 1863, xxv, p. 726).

|| Quoted by Pictet and Campiche as "*numida*."

¶ Gümbel (*Abhandl. Akad. Münch.*, x, p. 560,) is of opinion that Reuss' original identification of the species with Sowerby's *elongata* was correct.

** Eichwald (*Leth. ross.*, xme livr., p. 459,) quotes this species also from some nummulitic beds in the Crimea: are these eocene or cretaceous? Nummulites would not necessarily seem to be eocene, since their occurrence in cretaceous beds is believed to have been satisfactorily proved.

†† Gümbel (*Abhandl. Akad. Münch.*, x, p. 560,) notices an allied, but distinct species from Bohemia.

‡‡ Non *R. inflata*, Chem., nec *R. dentata*, Sow., both of which are recent species and belong to the sub-genus *Mantellum*.

164.—*R. procæna*, Gümbel, (Geognost. Beschreibg. Ostbay. Grenzgeb., 1868, p. 767), allied to *R. Cenomanensis*, d'Orb.; from Betzenstein (Bavaria).

165.—*R. guestphalica*, Schloenbach, (Neues Jahrb. f. Mineral. for 1869, extract of 'Beitrag zur Altersb. d. Grünsandes', &c. &c., p. 27), has the form of a *Plagiostoma*, but the valves are rather distinctly ribbed and appear to have been gaping as in *Mantellum*. The species is from the Greensand of Rothenfelde, near Osnabrück (Germany).

166.—*R.* [*? Plagiostoma*] *Althi*, Favre, Descript. moll. foss. de Lemberg en Galicie, 1869, p. 138, pl. xii, fig. 20.

167-168.—*R.* [*Limatula*] *subcarinata* et *Archiacana*, Briart et Cornet, Foss. de la meule de Bracquegnies, pp. 50 and 51, Mém. Cour. Acad. Belgique, vol. xxxiv, 1869-70.

169.—*R.* [*? Plagiostoma*] *acutirostris*, Eichw., (Leth. ross., xme livr., p. 471,) is noted simply from silicious cretaceous beds in the Govt. Orenburg.

Doubtfully cretaceous.

170.—*Ctenostreon distans*, Eichw., is placed by its author in the Neocomien, though it appears more probable that the Khoroshowo beds belong to the Jura, (Leth. ross., xme livr., p. 456).

171-175.—*R.* [*Plagiostoma*] *Fischeri*, Eichwald, (ibidem p. 464), *R. decemcostata*, Trautsch., (ibid. p. 466), *R. planicosta*, Trautsch., (ibid. p. 467), *R.* [*? Plagiostoma*] *irregularis*, Eichw., (ibid. p. 475), and *R.* [*Plagiostoma*] *incrassata*, Eichw., (ibid. p. 476), are also placed by Eichwald in the Neocomien, but whether correctly or not remains yet to be proved.

d. From Africa.

176-178.—*R.* [*Plagiostoma*] *Grenieri*, *R. Flattersi*, and *Delettrei* of Coquand are the only species known from Algiers, (Geol. and Paléont. Prov. Constant., p. 214).

e. From America.

179-186.—*R. acutilineata*, Conr., *crenulicosta*, Rømer, *denticulata*, Gabb, *leonensis*, Conr., *pelagica*, Mort., *reticulata*, Lyell and Forb., *squarosa*, Gabb, and *Wacoensis*, Rømer, are cited from North America in Check-list inv. foss., Smith. Misc. Coll., 1864, No. 177, p. 7.

187-188.—*R.* [*? Plagiostoma*] *microtis*, Gabb, *L.* [*? Limatula*] *appressa*, Gabb, Pal. California, vol. i, pp. 202 and 203.

189-190.—*R. Shastaensis* et *multiradiata*, Gabb, ibid. vol. ii, p. 201.

f. From Asia.

191-204.—*R.* [*Plagiostoma*] *nudata*, *Ootatoorensis*, et (*? P.*) *interpunctuata*, *R. insignis*, *interplicosa* and *scabricula*, *R.* [*Limatula*] *persimilis*, *R.* [*Ctenoides*] *tecta*, Goldf., *R.* [*? Ctenoides*] *scaberrima*, *R.* [*Acesta*] *obliquistriata* et *scrobiculata*, *R.* [*Ctenostreon*] *complanata*, will be described from the South Indian cretaceous deposits: of these only *R. tecta* is to all appearance undistinguishable from European specimens, but several others exhibit marked relations to European species; thus, for instance, *R. scabricula* to *R. granulata*, Goldf., *R. interplicosa* to *R. carinata*, Münst., *R. persimilis* to *R. semisulcata*, Nilss. Besides these I shall have to notice three forms which are no doubt distinct from any others, but the present materials are not sufficient for specific identification.

Limea.

205-206.—*L. exigua* et *biplex* are quoted by Eichwald from Neocomien beds, but these may also be jurassic (Leth. Ross., xme livr., p. 477).

207.—*L. Cenomanensis*, Guéranger, Album pal. d. l. Sarthe, 1867, pl. xxiv, fig. 9.

208.—*L. Oldhamiana* is the only species which occurs in the South Indian cretaceous deposits.

RADULA, *Klein*, 1753, (see p. 412).1. RADULA [PLAGIOSTOMA] NUDATA, *Stoliczka*, Pl. XXIX, Fig. 2.

R. [Plag.] ovato semiotundata, antice oblique sub-truncata, paulo inflata, lævigata, striis incrementi minutissimis, et in declivitate antica ac postica striis nonnullis radiantibus tecta, primis læviusculis, alteris scabriusculis; umbonibus prominulis, obtusis; auriculis inæqualibus, antica minima, postica multo majore; lunula longa, profunde excavata.

This species is distinguished by its semi-circularly ovate shape, slightly convex valves, and by the conspicuously scabrous radiating striæ on the lunular region; the anterior ear is very small, not visible in a lateral view of the shell. These characters easily separate the species from *Plag. Sowerbyi*, Gein., which has a somewhat similar form.

Localities.—Olapaudy, in a brownish ferruginous rock; Karapaudy, in whitish sandstone. Only one specimen from each locality was examined.

Formation.—Arrialoor group.

2. RADULA [PLAGIOSTOMA] OOTATOORENSIS, *Stoliczka*, Pl. XXIX, Fig. 3.

R. [Plag.] magna, semiovata, tumida, sub-lævigata, antice et postice sæpiusque prope marginem ventralem costulis lævigatis radiantibus notata, striis incrementi minutissimis, extra medium sulculis nonnullis fortioribus intersectis; auriculis parvis, antica minima.

A large, rather oblique, semiovate, and moderately tumid shell, apparently slightly gaping in front and behind; the surface is anteriorly and posteriorly, and often also near the ventral margin, marked with radiating slightly prominent ribs. The oblique form and uniform convexity of the valves distinguish this from other known cretaceous species.

Locality.—Ootatoor, in a pale brown earthy limestone.

Formation.—Ootatoor group.

3. RADULA [? PLAGIOSTOMA] INTERPUNCTUATA, *Stoliczka*, Pl. XL, Fig. 5.

Rad. testa oblique ovata, valva dextra moderate convexa, margine antero-ventrali truncato, postico convexo; superficie costulis planis, radiantibus undique ornata, lineis impressis, multo angustioribus et dense punctuatis separatis.

The obliquely ovate shape of the single, figured valve, which is slightly convex, and on the entire surface ornamented with flat, radiating ribs, separated by finely punctated, impressed lines, indicate a species distinct from any other cretaceous *Radula*. The posterior ear is distinct, but the anterior hardly visible, and the beak somewhat injured in the specimen. This makes the sub-generic determination somewhat doubtful, though the general character agrees better with *Plagiostoma* than with any other sub-genus.

Locality.—North-east of Ootatoor, in a yellowish brown limestone.

Formation.—Ootatoor group.

4. RADULA INSIGNIS, *Stoliczka*, Pl. XXX, Fig. 9.

Rad. valva dextra magna, crassa, oblique ovata, modice convexa costis (9 majoribus) radiantibus, leviter curvatis, sub-tuberculatis, hic et illic minoribus interpositis, ornata, in declivitate antica et postica sub-obsoletis; lunula profunda.

Only a single valve of this beautiful species has been obtained; the umbonal part with the upper edges of the ears is not preserved, but the remaining portions are sufficient to show the generic characters of the shell. It is ornamented with nine strong sub-tuberculated ribs and a few less distinct or nearly obsolete ones on the anterior and posterior declivities. Towards the umbo the strong ribs also seem to become less marked, while a number of thinner ribs make their appearance, especially when the outer glassy layer of the shell is decomposed.

Locality.—Near Moraviatoor, in a sandy limestone.

Formation.—Ootatoor group.

5. RADULA sp. indet.

A fragmentary valve of a large species of *Radula* was found in the coarse conglomeratic sandstone north of Kunnanore. It is of a broadly semioval shape, somewhat resembling *Radula Aubersonensis*, Pict. and Camp., (Pal. Suisse, vme ser., 4^{me} part., pl. 164, figs. 1-2), marked with about 26 radiating, strong, flattened ribs. The umbo and the ears are broken off, and as the shell surface itself also is not well preserved, I shall for the present defer naming the species.

Formation.—Arrialoor group.

6. RADULA sp. indet. Pl. XL, Fig. 4.

Another small costate valve of a *Radula* (or *Limea*) has been found in the earthy limestone west of Penangoor. It somewhat resembles in general character *Limea Oldhamiana*, but the ribs are more compressed and a little more distant; 14 in number. The surface is, however, not sufficiently preserved for a satisfactory determination of the species.

Formation.—Ootatoor group.

7. RADULA INTERPLICOSA, *Stoliczka*, Pl. XXX, Figs. 10–11.

Rad. oblique sub-ovata, inflata, radiatim multicostata, costis majoribus circa 30, æquidistantibus, acutis, antice et postice multo minoribus, et prope auriculas fere obsoletis, in interspatiis costulis tenuibus alternantibus instructa, costis et costulis minute granulatis; area ligamentali valde declivi, medio triangulariter excavata.

Shell obliquely ovate, tumid, ornamented with about 30 sharp ribs which alternate with much thinner ones; on the anterior and posterior declivity the ribs are finer, and near the ears they become almost quite obsolete: all the ribs are finely granulated.

Very closely allied to *R. carinata*, Münster, which appears to be a somewhat higher shell, with the intermediate ribs obsolete on the posterior part of the shell, while in the Indian form the intermediate ribs are all distinct when the shell surface is well preserved. Besides that, the granules on the ribs are much less developed in *carinata* than they are in *interplicosa*.

Locality.—In a whitish sandy limestone at Ninnyoor; rare.

Formation.—Arrialoer group.

A species, quite similar in form to *R. interplicosa*, occurs in a brownish limestone near Coonum, in a yellowish limestone near Odium, and in a pinkish sandy limestone near Moraviatoor; but all the specimens are mostly casts. One shows portions of the shell surface preserved, on which intermediate lines are traceable between the larger ribs; but this character is not sufficient to decide upon the identity of the two forms. All three last quoted localities belong to the Ootatoor group.

8. RADULA sp. indet., Pl. XXXVI, Fig. 6.

Two fragmentary right valves of a peculiar species of *Radula* were found in a light grey sandstone south-east of Arrialoer; they are obliquely ovate, moderately tumid, with unequal ears, and covered with numerous rather fine radiating ribs, scaly when well preserved. The two specimens evidently indicate a more tumid species than *Rad. obliqui-striata*, but they are not sufficient for specific determination.

Formation.—Arrialoer group.

9. RADULA SCABRICULA, *Stoliczka*, Pl. XXX, Fig. 8.

Rad. valva oblique rotundato-ovata, tumidula, parva, radiatim circa 24-costata, costis trispinulosis, series medianæ spinulis vel tuberculis ceteris paulo majoribus, interspatiis angustis, rugulosis; auriculis parvis; umbone paulo exstante, breviter acutato.

A small, slightly oblique, roundly ovate, and rather tumid shell, with the beaks obtusely pointed and slightly prominent beyond the cardinal margin; the surface is marked with about 24 radiating ribs, each of which is provided with three rows of small spinulose tubercles, the median being a little larger than the lateral ones; the interspaces between the ribs are finely concentrically rugose, these concentric rugose lines becoming more distinct on the anterior or posterior declivities of the shell, where the radiating ribs decrease in size.

The species is closely allied to *R. granulata*, Nilss., differing from it by a more rounded shape, by the ribs being covered with small spinulose tubercles of subequal size instead of spinulose scales, and by the rugose lines in the furrows separating the ribs.

Locality.—Comarapolliam, in soft, coarse sandstone. Only a single left valve has been examined.

Formation.—Arrialoer group.

10. RADULA [LIMATULA] PERSIMILIS, *Stoliczka*, Pl. XXIX, Figs. 4-5.

R. [Lim.] testa elongata, paulo obliqua, inflata, antice et postice leviter convexa, infra sub-rotundata, medio costulis tenuibus 15-20, radiantibus, striis incrementi minutissimis, confertissimis et nonnullissulcis profundioribus intersectis, tecta; umbonibus tumidis, angustis, modice projicientibus; auriculis parvis, ad marginem superum paululum incrassatis, declivis, in utroque latere submargine leviter insinuatis; area cardinali obliqua, medio fovea triangulari ligamentifera, lata, instructa.

Shell elongated and rather inflated, slightly oblique, with somewhat compressed, tumid, and moderately projecting umbones; the margin of the ears is slightly thickened; the median convexity of each valve is marked with 15-20 radiating ribs, sharp, but not much prominent, slightly rugose by the numerous and fine striæ of growth, and intersected by a few more distant narrow grooves indicating stages of growth. Young shells have sometimes only 15 radiating ribs; they are always more inflated and narrower when compared with full grown specimens, in which the number of ribs rises to 20.

This species is very closely allied to some of the forms which are usually referred to *R. semisulcata* of Nilsson. There are, however, at least two different species mixed up under this name. Sowerby's *semisulcata* from Blackdown is distinct from that of Nilsson, and it is not certain whether the form delineated by Goldfuss under that same name does also not refer to a distinct species, while that figured by d'Orbigny comes very close to Nilsson's type. The Indian form differs from all these by the more distant and almost smooth radiating ribs; but their number agrees especially with Goldfuss' *semisulcata*: the only difference between the two is, that the European form is a little shorter than the Indian. D'Orbigny's *semisulcata* has the ribs very distinctly spinulose and is less inflated than *persimilis*.

Localities.—Near Poothoor and Kullay, in a yellowish brown limestone, and north of Odium, in a brown sandy limestone.

Formation.—Ootatoor group.

11. RADULA [CTENOIDES] TECTA, *Goldfuss*, Pl. XXX, Fig. 12.

1836. *Lima tecta*, Goldfuss, Petr. Germ. ii, p. 91, pl. 104, fig. 7.

1837. ? *Lima frondosa*, Duj., Mém. Soc. Géol., 1^{re} ser., pt. ii, p. 227, pl. 16, fig. 10.

1839. *Lima lamellosa*, Rœmer apud Geinitz, Char., pt. i, p. 23.

1841. *Lima tecta*, apud Rœmer, Verst. Nordd. Kreid., p. 58.

1843. ? *Lima* „ d'Orbigny, Pal. franç. terr. cret., iii, p. 547, p. 419, figs. 5-8.

1867. *Lima* „ Guéranger, Album paléont. de la Sarthe, pl. xxiv, fig. 11.

R. [Cteno.] testa elongate sub-ovata, paulo obliqua, convexe compressiuscula, antice oblique sub-truncata, auriculis magnis inæqualibus et umbonibus depressiusculis instructa, costulis confertis radiantibus, sæpe irregulariter dichotomis, atque lamellis 16-20 concentricis, exstantibus et in auriculas continuis tecta.

I can see no difference between Indian specimens of this characteristic species and those from Europe. When the ears are broken away, the shape of the

shell becomes rather regularly semiovate. In this state it appears to have been figured as *L. frondosa* by Dujardin, with which d'Orbigny identifies a fragmentary specimen from the turonien. Pictet and Campiche question this identification; but if d'Orbigny's species be the same as the one figured by Guéranger, I hardly think that it could be considered as a distinct species.

Locality.—North of Poodoopolliam, in a light-coloured sandy limestone.

Formation.—Arrialoore group.

The species is a characteristic upper cretaceous fossil; it has been found at numerous localities in France and in Germany.

12. *RADULA* [? *CTENOIDES*] *SCABERRIMA*, *Stoliczka*, Pl. XXX, Fig. 1.

Rad. [*Cteno.*] *testa oblique ovata, valvis lente convexis, superficie undique costulis radiantibus confertissimis, fortioribus et tenuioribus alternantibus, omnibus scaberrimis, ornata; auriculis sub-æqualibus, radiatim crasse costulatis, costulis spinulosis, auricula postica altera majore, ultima infra marginem superiorem leviter insinuata.*

An obliquely ovate, moderately convex shell, with rather large subequal ears, the umbones only slightly projecting beyond them; the surface is covered with very closely-set radiating ribs, thicker and thinner ones alternating, and all are so densely ornamented with sharp spinous scales that the surface receives the appearance of a fresh file; it is, however, rarely that these scales remain well preserved; near the umbones particularly they soon wear off. On the larger posterior ear, the radiating spinulose ribs are considerably stronger than on the anterior one.

Locality.—Near Olapaudy, in a brownish ferruginous rock.

Formation.—Arrialoore group.

13. *RADULA* [*ACESTA*] *OBLIQUI-STRIATA*, *Forbes*, Pl. XXX, Figs. 2-5 and 13.

1846. *Lima obliqui-striata*, Forbes, Trans. Geol. Soc., London, vii, p. 154, pl. 18, fig. 13—*eadem auctorum*.

R. [*Acesta*] *testa obliqua, sub-ovata, lente convexa, antice oblique truncata, lunula paulo excavata, superficie costulis radiantibus numerosis, aut muricatis, aut sublævigatis, prope umbones obsoletis, tecta; auricula antica minima, postica distincta, margine superiore declivi, fovea ligamentali paulo excentrica.*

The form of the shell slightly varies from narrowly to broadly semiovate, as indicated in the figures quoted above; towards the periphery the shell is always markedly flattened. The radiating ribs are very numerous and close together, and when well preserved, ornamented with numerous spinulose scales; near the beaks they generally become obsolete, and near the periphery their straight direction is often made slightly to deviate by concentric lines of growth. The anterior ear is very small, as in all species of *Acesta*, the posterior considerably larger and

obliquely descending; the ligamental pit lies below the beak, somewhat posteriorly from the centre.

Localities.—Near Comarapolliam and north of Arrialoor, in coarse silicious sandstone; near Poodoopolliam, in white earthy limestone.

Formation.—Arrialoor group.

There are two species which deserve notice, as being closely allied to the Indian species: *R. Rauliniana* and *ornata* of d'Orbigny; the former is from the Gault, and differs only by a slightly more expanded posterior ear; the other is upper cretaceous, and has the anterior side somewhat more incurved. A comparison of well preserved specimens of these, and one or two closely allied species from the German upper cretaceous beds, would be very desirable, as, for instance, *R. aspera*, Münst., particularly the form figured by Reuss from Bohemia.

14. RADULA [ACESTA] SCROBICULATA, *Stoliczka*, Pl. XXIX, Fig. 6.

R. [Ac.] testa late semi-ovata, obliqua, compressiuscula, antice recte sub-truncata, postice rotundata, auriculis parvis, antica minima, lunula paulo excavata; superficie striis vel costulis radiantibus, sub-obsoletis, scobinatis, in parte antica magis distinctis, notata.

Shell rather broadly semiovate; valves slightly convex, anteriorly truncate; ears small, the anterior scarcely visible in a side view; lunula slightly excavated; surface marked with indistinct radiating scaly ribs, or rather striæ, somewhat more distinct on the anterior portion of the shell. Sometimes the scales wear off on the ribs altogether, while the cross lines connecting them, and situated in the furrows between the ribs, partially remain preserved, and this gives the shell quite a distinct appearance from that it originally possessed. The largely ovate, almost semicircular, and rather compressed shape of the valves readily distinguish the present species from any other known from cretaceous rocks; it in some respect resembles the shape of *Plagiostoma*.

Locality.—Near Olapaudy, in a brownish ferruginous rock.

Formation.—Arrialoor group.

15. RADULA [CTENOSTREON] COMPLANATA, *Stoliczka*, Pl. XXX, Fig. 14.

R. [Ctenost.] valva sinistra elongata, deplanata, medio costis 10, radiantibus, crassis notata, antice et postice lævigata; auriculis magnis, postica minore, antica, majore, ad marginem inferiorem (lateralem) simplici, ad anticum (superiorem) paulo incrassata et in latere interiore sulco latiusculo instructa.

Only a single valve of this interesting species was found; it belongs to the sub-genus *Ctenostreon*, the larger anterior auricle being internally provided with a shallow but distinct groove for the passage of the byssus; at the margin itself the groove is indicated by a very slight insinuation (which is scarcely sufficiently indicated in fig. 14, pl. xxx). The left valve is very slightly convex and marked

with ten strong radiating ribs, the anterior and posterior portion of the shell being smooth.

Locality.—Cullpaudy, in a whitish coralline limestone.

Formation.—Ootatoor group.

LIMEA, Bronn, 1831, (see p. 413).

1. LIMEA OLDHAMIANA, Stoliczka, Pl. XXX, Figs. 6-7, and Pl. XXXVI, Fig. 5.

L. testa oblique obovata, tumidula, costis radiantibus 12-14, acutatis, longitudinaliter sæpe indistincte striolatis seu costulis filiformibus alternantibus et alteris lineis incrementi confertissimis transeuntibus ornata; auriculis parvis, fere æqualibus; fovea ligamentali triangulari, profunda, margine cardinali in utroque latere dentibus 4-5, obliquis, externis ceteris minoribus, instructo.

The surface of each valve is marked with 12-14 strong radiating sharp ribs, which are finely striolated, and sometimes there is a fine rib visible in the interspaces. The ears are nearly quite equal, and each is internally provided with four or five small oblique teeth; the ligamental pit is triangular, median, and very deep.

The ornamentation of this interesting species closely resembles that of *Radula Reichenbachii*, Gein., but the ribs are more numerous and sharp. It also closely resembles *Limea Cenomanensis*, Guér., but is evidently a more oblique shell.

Locality.—Stripermatúr, in a coarse conglomeratic sandstone.

Formation.—Arrialoor group.

XLII. Family,—PECTINIDÆ.

The animals have the mantle margins somewhat thickened, flattened internally, provided with several rows of elongated unequal cirrhi; those on the external edge are usually longer and possess at their inner bases a row of ocelli; gills long, semicircularly curved, attached to the anterior and lower base of the adductor, each leaf is doubled on itself, but the duplicature does not reach the base, the posterior ends are free; the fillets composing the gills are very loose; labial palps subtriangular, transversally elongated, short, truncate at the end, smooth externally, and more or less distinctly pectinately striated internally, narrowly united in front; foot small, subcylindrical, sometimes a little flattened at the end, anteriorly grooved, and at the base with a gland, often secreting a bundle of thin, long byssal threads; adductor subcentral, subcylindrical, short, but very strong. The pedal muscle is very short; in those species which do not develop a byssus it is confluent with the upper muscular mass of the adductor; in others which secrete a byssus it is elongated, and the short ends are attached to the valves at the upper posterior end of the adductor. The rectum is thin and very long, grown to the posterior side of the adductor, with the end produced into a free tube, reaching as far as the termination of the gills.

The shells are ovate or rounded, more or less equilateral, equivalve or inequivalve, with one valve attached, or with both free, the valves being auricled at both sides of the beak, and the anterior ear of right valve generally provided with a short byssal sinus at its base; ligament marginal, cartilage internal, usually filling out a triangular pit in the umbonal region; adductor scar rounded.

The number of fossil species belonging to the present family is very great; they already appear in the oldest sedimentary deposits and continue up to the present time, there being over 200 recent species known. Comparing with this the numerous fossil species in the different formations, it is seen that those of the cretaceous period are more than equal to it; during the eocene formation it is conspicuously less. On the whole, the fossil species are much more numerous than the recent ones.

1. *Aviculopecten*, M^cCoy, 1855, (British Palæoz. rocks and fossils, p. 392). Shell somewhat inequivalve, more or less inequilateral, being often extended posteriorly, with both valves moderately convex and broadly rounded; anterior ear flattened, smaller than the posterior, and with a byssal sinus at the base; posterior ear rarely projecting beyond the margin of the shell, often with a shallow emargination; ligament placed in a narrow foss along the hinge margin, and not in a median cartilage pit as in *Pecten*. Type, *A. concavus*, M^cCoy, from upper palæozoic rocks.

Most of the species of this genus are of a broadly rounded form, and the surface is covered with very numerous radiating ribs, as in *Pecten*; but the ligamental fosset appears to resemble that of many *Aviculæ* and *Pterineæ*. Meek (Americ. Journ., Sc. and Arts, XXXVII, 1864, p. 217), says that the structure of the shell of *Aviculopecten* is tabular, as in the *PECTINIDÆ*, and not prismatic, as in the *AVICULIDÆ*; but it may be doubted whether that is sufficient ground for excluding the present genus from the family *AVICULIDÆ*.

All the species of *Aviculopecten* as yet known are from palæozoic beds.

2. *Pernopecten*, Winchell, 1865, (*vide* Woodward's Man., Appendix, p. 65). Subequivalve, inequilateral, with subequal ears, surface almost smooth, hinge-line straight, with a central cartilage pit and a number of smaller pits on either side, diminishing in size and depth from the centre outwards. Type, *P. limæformis*, W., from carboniferous rocks. The species of this genus are externally allied to *Amusium*, which also has sometimes a few oblique ridges on the internal side of the hinge-line, but not such a regular series of pits and tubercles as described in *Pernopecten*. It is, however, doubtful that those pits are intended for the reception of portions of the ligament, they are probably simple interlocking teeth, but if they really were ligamental pits, the genus ought to be placed in the *MELININÆ*.

3. *Pecten*,* Klein, 1753. Shell suborbicular, or somewhat higher than long, equivalve, or very nearly so, closed; surface generally with radiating striæ or ribs;

* Klein was the first author who used the word *Pecten* in a strictly generic sense, though he did not discriminate very accurately between the species; but his classification of the shells allied to *Pecten*, as typified by *P. varius*, Linné, is admirable. He figures as typical species a form which is very closely allied to, or identical with, *P. miles*, Reeve.

* He ought to have seen a later paper published by me in the Jour. of Science, in which I showed that the outer layer of the shell in this genus is prismatic, and consequently referred it to the *Aviculidæ*. The specimens first examined by me had lost their outer layer.

ears unequal, the anterior being the larger, in the right valve provided with a deep byssal sinus; hinge-line straight, ligament marginal, linear, cartilage lodged in a usually central and triangular pit, from the top of which often one to three ribs radiate; muscular scar large, sub-central. Type, *P. varius*, Linné.

The name *Pecten* should be reserved for the species strictly represented by the above type. The shells are generally somewhat higher than long, the surface is covered with numerous scabrous, denticulated or scaly, radiating ribs and striæ, and the anterior ear of the right valve is generally somewhat ascending, the ears themselves being of moderate size in proportion to that of the shell itself. The typical *Pectines* occur through all formations from the oldest upwards, and are most numerous at the present time.

3 a. *Chlamys*, Bolten, 1798. *P. bifrons*, Lam., should be considered as the type of this sub-genus. It represents a group of *Pectines* which are generally somewhat inequivalve, of a broadly rounded form, ornamented with largish, transversally finely serrated or striated radiating ribs, and with comparatively large, sub-equal ears. Among other typical forms of this sub-genus, I would quote *P. opercularis*, Lam., *leopardus*, Reeve, *solaris* and *nucleus*, Born, *squamatus*, Gmel., &c.; but I would exclude *islandicus*, which is stated to belong to this sub-genus, though it does not appear to differ from *Pecten* as restricted. H. and A. Adams also quote *ornatus*, Linné, which is a *Pecten*, and *vitreus* and *striatus*, which may better be classed with *Pseudamusium*.

3 b. *Liropecten*, Con., 1867, (*Lyropecten*,* Am. Journ. Conch., III, p. 6). Somewhat inequivalve, with moderately developed unequal ears, valves ornamented with strong nodulose and striated ribs, near the umbones always somewhat irregularly gibbose; hinge with a few oblique teeth on each side of the ligamental fosse. Type, *P. nodosus*, Linn.

There are a few tertiary species from N. America referred to this sub-genus, and it is very likely also that species like the cretaceous *P. septemplicatus*, Nilss., and a few others, belong to it.

3 c. *Pallium*, Martini, 1773, (*Dentipecten*, Rüpp.). Shell generally somewhat higher than long, equilateral, sub-equivalve, with moderately numerous, strong radiating ribs, small, sub-equal ears, more or less distinctly toothed on the internal hinge-margin. Type, *P. plica*, Linn.

3 d. *Camptonectes*, Agassiz, 1864, (teste Meek in Check-list, cret. and jur. inverteb. foss., N. America, p. 28, (No. 891); Smith. Misc. Coll., No. 177; = *Eburneopecten*, Con., 1867, Am. Journ. Conch., III, p. 140). Valves sub-equal, moderately flattened, ovate or sub-ovate, with well developed, or rather small, unequal ears, the anterior of the right valve with a byssal sinus, surface marked with fine radiating, curved, striæ, separated by punctated grooves. Type, *P. lens*,

* Conrad, loc. cit., discusses the affinities of his *Lyropecten* to *Pallium*, Klein, which, he says, is founded on *Pect. pallium*. Klein has no genus of that name, for what he calls *Pallium variegatum*, &c., &c., is a form of his second species in the "genus *Pecten*" (vide Ostrac., pp. 130—131), and therefore the name *Pallium* could not have been considered as generic by Klein.

Sow. Forms belonging to this sub-genus only occur in the mesozoic strata. The two valves often are unequally strongly striated.

3 e. *Pseudamusium*, Klein, 1753. Shell usually fan-shaped, thin, sub-equivalve, valves smooth or finely radiately striated and plicated; ears of moderate size, sub-equal or unequal, with straight hinge-line; byssal sinus of anterior ear small; type, *Pecten exoticus*, Chem. (*Pseudamusium-Pecten lævis*, &c., of Klein). This should be retained only for species of the above type, like *P. corneus*, Sow., *hyalinus*, Poli, *tigrinus*, Müll., *natans*, Phil., &c., which are closely allied to *Amusium*, differing from it by having the valves perfectly closed.

3 f. *Syncyclonema* has been proposed by Meek (1864, Smith. Misc. Coll., No. 177, p. 31), for a small species formerly described as *Pecten rigida*, Hall and Meek (= *J. Hallii*, Gabb, Am. Phil. Soc., VIII, p. 214). The valves are nearly equal, ovately sub-orbicular, rather compressed, closed, smooth, or concentrically striated, and with unequal ears. There appears to be no essential difference between that species and *Pseudamusium* as restricted, except that the shell is somewhat higher than long or wide, while the species of *Pseudamusium* usually are wider than high. A great number of cretaceous species differ in that respect from *Pseudamusium*, and the name can, therefore, be appropriately reserved for them.

4. *Amusium*, Klein, 1753, (*Pleuronectia*, Swains., 1840). Shell sub-orbicular, subequivalve, rather thin and gaping in front and behind; surface of valves smooth or indistinctly radiately striated; ears of proportionate size, sub-equal, with a slightly angular hinge-line, the upper edges of the ears a little ascending, the anterior ear of the right valve often with a very small byssal sinus; hinge-line generally with one or two radiating ribs from the centre, superseded by the linear ligament; cartilage pit of moderate size, triangular, central. Type, *Am. pleuronectes*, Linn.

The two valves of *Amusium* are often differently coloured, and occasionally one of them shows fine radiating ribs, while the other is perfectly smooth. This character appears to have been rarely noticed in fossil shells, and therefore the two valves are occasionally found described under two different names. Species of the genus are not numerous in the present seas; there are a few recorded from tertiary strata, and a larger number of similar forms is known from mesozoic beds; but it is often difficult to determine whether they belong to this genus. Many species appear to have the valves closed, and these must, therefore, be referred to the sub-genus *Pseudamusium* or *Syncyclonema*.

5. *Vola*, Klein, 1753, (*Janira*, Schum., 1817, *Neithea*, Drouet, 1824). Shell suborbicular, inequivalve, closed, radiately ribbed, right valve convex, left flattened or concave, and often somewhat smaller; ears rather large, sub-equal, the anterior of the right valve generally with a conspicuous byssal sinus; hinge-line straight or nearly so, often slightly thickened at the margin, and with a few ribs radiating from the centre; cartilage pit triangular, central, deep. Type, *Vola Jacobæa*, Linn., from European seas. The species which Klein figures as "*Indica*," &c., is probably *V. Sinensis*, Sow.

Fossil species first appear in the lowest of cretaceous deposits, and some of them have a very great, almost general, geographical distribution in the higher strata of this formation. During the upper tertiary and the recent epoch, the species attain a larger size than any other *PECTINIDÆ*.

6. *Hemipecten*, Adams and Reeve, 1849, (Proc. Zool. Soc., p. 133, Reeve, Iconica, vol. VI). Shell somewhat irregularly orbicular, inequivalve, valves very thin, hyaline; posterior ears not well developed, anterior better defined, flattened, that of the right valve with a very deep byssal sinus, which has the lower edge denticulate; hinge-line almost straight, with a thin marginal ligament, internally edentulous, and with a small subcentral marginal cartilage pit; right (or usually called lower) valve flatter than the left one, which is more or less convex. Type, *Hem. Forbesianus*, Ad. and R., from the Sooloo Archipelago, is the only recent species known. It appears to adhere temporarily by the right flattened valve to sub-marine objects; its thin hyaline structure is very characteristic, and so is also the small marginal cartilage pit.

I believe that several of the fossil mesozoic species described under the name *Hinnites*, but distinguished from typical forms of this genus by a greater inequality of the valves and thin structure, are referable to *Hemipecten*, and the same may be the case with some of the jurassic *Placunopsis*; but the materials upon which particularly the latter genus has been founded are in many respects so insufficient that it is extremely difficult to institute a proper comparison of these shells with *Anomia*.

7. *Hinnites*, Defr., 1821. Valves more or less solid, radiately ribbed externally and often foliated, right valve partially attached, often slightly larger and irregular; area between the hinge and the beaks more or less developed, striated, traversed by a central cartilage groove, somewhat extending internally; hinge edentulous; hinge-line unequally eared on both sides, the right valve with a byssal sinus, as in *Pecten*; muscular scar sub-central, large; type, *H. Cortesii*, Def., a tertiary fossil species. This genus is represented from the oldest sedimentary deposits through all the periods, but only about four recent species are known; it appears to have had its greatest development during the mesozoic epoch.

The character of the shell strongly recalls that of *Pecten*, differing from it by the sessile habitat at certain stages of age, and by the peculiar development of the hinge area in the left valve. From *Terquemia* it differs by the lateral ears and the byssal sinus. It appears to have preceded *Spondylus* in geological history, and forms an intermediate link between this genus and *Pecten* or *Ostrea*, while *Terquemia* connects in a similar manner *Plicatula* and *Ostrea*. The thin, almost hyaline, fossil species of *Hinnites* may, as already noticed, partially belong to *Hemipecten*.

LIST OF CRETACEOUS SPECIES OF *PECTINIDÆ*.

Pictet and Campiche (Pal. Suisse, V^{me} ser., 4^{me} part., p. 177 et seq.), class the species of this family under three generic names: *Pecten*, *Janira* (= *Vola*), and *Hinnites*. In the subsequent list I shall note the sub-generic names in parentheses, and make a few additions.

Pecten and its sub-genera, (*vide* Pict. and Camp., l. cit., p. 210).

1-2.—*Pecten Astierianus*, d'Orb., (= *Euthymi*, Pictet), *Martinianus*, d'Orb.

3-4.—(? *Pect.*) *icaunensis*, Cott., (? *Pect.*) *proboscideus*, d'Orb.; these two species appear to be closely allied to *Ctenostreon* (see p. 413).

5-15.—*P. Goldfussi*, Desh., *P.* [? *Chlamys*] *lineato-costatus*, Römer (Ool., pl. 18, fig. 27), *P. Archiacianus*, d'Orb., *P. sanctæ-crucis*, P. and Camp., *P. Carteroni*, d'Orb., *P. Lardyi*, P. and C., *P. Urganensis*, Lor., *P. Lauderonensis*, Lor., *P. Coquandianus*, d'Orb., *P. Robinaldinus*, d'Orb. (= *obliquus*, Forbes, = *interstriatus*, Leym., = *aptiensis*, P. and Roux); *P. Oosteri*, Lor.

16-17.—*P.* [*Camptonectes*] *striato-punctatus*, Römer, *P.* [*Camptonectes*] *arzierensis*, Lorient.

18-22.—*P.* [*Pseudamusium*] *alpinus*, d'Orb., (= *P. Agassizi*, Pict. et Lorient), *P.* [*Syncyclonema*] *Cottaldinus*, d'Orb., *P.* [*Pseudamusium*] *crassitesta*, Römer, *P.* [*Syncyclonema*] *Matheronianus*, d'Orb., (*pulchellus*, Math., non Nilsson), *P.* [*Camptonectes*] *Lusitanicus*, Sharpe.

23-27.—*P.* [? *Syncyclonema*] *Greppini*, P. and Renev., *P. aptiensis*, d'Orb., (*interstriatus*, d'Orb., non Münster), *P. Daubrei*, Coq., *P. Morellensis*, Coq., *P. Achates*, Coq.

28-38.—*P. Dutemplei*, d'Orb., *P. Raulinianus*, d'Orb., *P.* [*Chlamys*] *Rhodani*, P. and Roux, *P. Saxoneti*, P. and Roux, *P. Ricordeanus*, Cott., *P.* [? *Syncyclonema*] *Darius*, d'Orb., *P. Vraconensis* et *Viteli*, P. and Camp., *P.* [*Syncyclonema*] *orbicularis*, Sow., *P.* [*Chlamys*] *asper*, Lam., *P.* (? *Pseudamusium*) *pygmæus*, Buv.

39-41.—*P. compositus*, *Milleri* et *Stutchburianus*, Sow.

42.—*P. Beaveri*, Sow., resembles in shape and in the form of the ears *Amusium*, but the radiating ribs are of exactly the same character as usually seen in *Chlamys*.

43.—*P. triplicatus*, Mant. The description does not exactly correspond with the figure; the latter represents an imperfect shell, more resembling the flat valve of a *Vola* than anything else.

44-50.—*P. obliquus*, Sow., *P.* [*Chlamys*] *cenomanensis*, d'Orb., *P. subacutus*, Lam., (= *Brongniarti*, d'Orb.), *P. elongatus*, Lam., *P. Galliennei*, d'Orb., *P.* [*Syncyclonema*] *Neptuni*, d'Orb., *P.* [*Syncyclonema*] *Calypso*, d'Orb.

51-60.—*P.* [*Camptonectes*] *Rotomagensis*, d'Orb., *P. Passyi*, *subdepressus* et *subinterstriatus*, d'Arch., *P.* [*Camptonectes*] *virgatus*, Nils. (non *idem* apud d'Orbigny, *vide* p. 433), *P. Puzosianus*, Math., *P.* [*Syncyclonema*] *Requienianus*, Math., *P. Barbesillensis*, *P. Marrottianus* et *Royanus*, d'Orb.

61-70.—*P. Espaillaci*, d'Orb., *P. cretosus*, Defr., (= *arachnoides*, Defr., sed non = *P. Zeisneri*, Alth), *P. Mantellianus*, (= *concentricus*, Woodw.), *Campaniensis*, and *Girondinus*, d'Orb., *P. medioplicatus*, *Regleyi* et *recurrens*, Coq., *P. Matronensis*, d'Orb., *P. Palassoui*, Leym.

71-80.—*P.* [? *Amusium*] *Nilssoni*, Goldf., *P.* [*Chlamys*] *Dujardini*, Römer, *P.* [*Pallium* seu *Chlamys*] *asellus*, Sow., *P. nitidus*,* Mant., *P.* [? *Syncyclonema*] *lævis*, Nils., *P.* [*Syncyclonema*] *membranaceus*, Nilss., *P.* [*Pseudamusium*] *circularis*, Goldf., *P.* [*Pseudamusium*] *subsquamula*, d'Orb., *P.* [? *Syncyclonema*] *exilis*, Reuss, *P.* [*Camptonectes*] *occulte-striatus*, Zitt.

81-90.—*P.* [*Pseudamusium*] *pusillus*, Alth. (non *P. pusillus*, Münster. ex Schlotheimi *Discite pusillo* apud Goldfuss); *P.* [*Pseudamusium* seu *Amusium*] *abbreviatus*, *rotundatus*, *Jugleri* et *latus*, Hagenow, *P.* [*Camptonectes*] *curvatus*, Gein. (= ? *divaricatus*, Reuss), [*Camp.*] *concentrice-punctatus* et *granulifer*, Reuss, *P. spatulaformis*, Reuss, *P.* [*Camp.*] *fraudator*, Zittel.

91-100.—*P. comans*, Römer, *P. serratus*, Nilss., *P. hispidus*, Goldf., *P. acuminatus*, Gein.,† *P.* [*Chlamys*] *squamifer*,‡ Gein., *P.* [? *Chlamys*] *depressus*, Münster, *P. pulchellus*, Nilss. (= ? *sub-*

* Appears to be more numerous ribbed than *cretosus* of DeFrance; it is not probable that both are identical.

† *P. decipiens*, Reuss = *Vola lævis*, Drouet.

‡ Geinitz and Pictet consider Münster's *P. decemcostatus* as probably identical with this species, but Bosquet quotes the former as distinct, (Fauna and flora of Limbourg, Staring's Bodem van Nederland, II^{de} deel).

pulchellus, d'Orb., = *Staszycii*,* Alth), *P.* [*?Liropecten*] *septemplicatus*, Nilss., *P.* [*?Pallium*] *sparsinodosus*, Zitt., *P. undulatus*,† Nilss., non Goldf., nec Sow., see *P. raduloides*, p. 431).

101-110.—*P. Faujasi*, *sectus*, *trigeminatus* et *cicatratus*, Goldf., *P. Reussi*, d'Orb., (= *obliquus* apud Reuss), *P. subgranulatus*, Münster., *P.* [*Chlamys*] *seriato-punctatus* et *multicostatus*, Nilss., (non *idem* Reeve), *P. subaratus*, Nilss., *P. miscellus*, Münster.

111-120.—*P. submuricatus*, d'Orb., *P. complicatus*, Goldf., *P.* [*?Chlamys*] *actinodus*, Goldf., *P. Althi*,‡ Favre (= *Besseri*, Alth, non Andrzejowski), *P. excisus*,‡ Pusch, *P.* [*?Pseudamusium*] *semiplicatus*, Alth,§ *P.* [*Chlamys*] *acuteplicatus*,|| Alth, *P. denticulatus*, *nodosocostatus* et *inflexus*, Hagenow.

121-130.—*P. striatissimus*, *Leonhardi*, *variabilis*, *trisulcus* et *Weissii*, Hagenow, *P.* [*Syncyclonema*] *sul laminosus*, Favre, *P. Zeisneri*, Alth, *P. Stachei*, Favre, *P. subexcisus*, Favre, *P. scissus*, Favre; (for the last named five species *vide* Favre in Descript. de foss. de Lemberg, 1869, pp. 143 et seq.).

131.—*P. Galicianus*, Favre, (ibidem p. 153).

132.—*P. glauconeus*, Tate, from upper cretaceous rocks of Ireland (Quart. Journ. Geol. Soc., Lond., 1865, xxi, p. 39).

133.—*P. tricostatus*, Müller, Suppl. Petref. Achener Kreidef., 1859, p. 8.

134-135.—*P.* [*?Pseudamusium*] *zonarius* and *P. imbricatus* (non *idem* Gmel. nec Desh.) are described by Eichwald from his so-called Neocomien (? jurassic) beds at Khoroschowo, near Moscou, (Leth. ross., xme livr., 1867, pp. 435 and 440).

136-137.—*P.* [*Chlamys*] *meridionalis* and *dimotus*, Eichw., (*ibid.*, pp. 448 and 451); the former is reported from uncertain glauconitic beds in the Crimea, and the latter from a cretaceous marl near Pawlograde in the Govt. Ekatarinoslaw.

138.—*P.* [*Chlamys*] *rarispinus*, Reuss, (Böhm. Kreidef., pt. ii, p. 31, pl. 39, fig. 15,) is considered by Gümbel to be a species distinct from *Dujardini*, Römer (Abhandlung. Akad. München, 1868, x, p. 562).

139-141.—*P. Desvauxi*, *Tenouklensis* and *numidus*, Coq., (Paléont. Prov. Const., p. 218,) from Algiers; all appear to belong to the sub-genus *Chlamys*.

Baily (Quart. Journ. Geol. Soc., Lond., xi, p. 462,) noticed from South Africa a species allied to Nilsson's *P.* [*Camptonectes*] *virgatus*.

142-151.—*P.* [*?Pseudamusium*] *Argillensis*, Con., *P.* [*Camptonectes*]¶ *Burlingtonensis*, Gabb, *P. craticula*, Mort., (non *crassacula*, errore typ. apud Pictet et Campiche), *P. Mississippensis*, Con., *P. Nebrascensis*, M. and Hayd., *P. tenuitesta*, Gabb, *P.* [*Camptonectes*] *texanus*,** Gabb, *P.* [*Chlamys*] *venustus*, Morton, *Syncyclonema rigida*, H. and M. et ? *simplica*, Con., (*vide* Meek's Check-list cret. foss., Smiths. Misc. Coll., No. 177, p. 7).

P. [*Pseudamusium*] *Nilssoni*, Goldf., (haud *Neilsoni* apud Meek) was recorded from Texas by Römer.

* Moll. foss. de Lemberg, 1869, p. 145. It is extremely difficult to judge from figures as to the identification of so closely allied forms as those recorded by various authors under the name *pulchellus*. Nilsson's typical form must be examined. With it appears to be identical Münster's *spurius* apud Goldfuss, but for Goldfuss' *pulchellus* d'Orbigny proposed the name *sub-pulchellus*; and, again, Gümbel lately used the name *sub-pulchellus* for Reuss' *subaratus* = *pulchellus*, Gein., (Abhandl. Akad., Münich., 1868, x, p. 562).

† Bosquet identifies this species with *P. cretosus* of DeFr., (see Fauna and flora of Limbourg in Staring's Bodem van Nederland, II^{de} deel).

‡ Favre, Moll. foss. de Lemberg, 1869, p. 154. § Favre, *ibidem*, p. 150. || Favre, *ibidem*, p. 148.

¶ See Conrad in Am. Journ. Conch., vol. vi, p. 76.

** Originally described by Römer as *P. virgatus*; it does not appear to differ from *P. curvatus*, Geinitz, (see p. 433).

152-154.—*Pecten Traskii*, P. [*Syncyclonema*] *operculiformis* and P. [*Pseudamusium*] *Californicus*, Gabb, are from California (Pal. Calif., vol. i, pp. 200 and 201).

155-157.—*P. Martinezensis*, *complexicosta* et *interradiatus*, Gabb, *ibidem*, vol. ii, pp. 198 and 199.

158-159.—*P. delumbis* et *obrutus*, Con., (Lynch's Exped. to Palæst., p. 225). The former is considered by Fraas (Württemberg. Jahresh., xxiii, 1867, p. 232,) as identical with *P. Nilssoni*, and the latter, he believes, is the same species which Conrad describes as *Avicula Samariensis*.

The following species occur in the South Indian cretaceous deposits :—

160-169.—*P. Anapaudiensis*, *raduloides*, *Verdachellensis*, *Arcotensis*, P. [*Chlamys*] *asperulinus*, P. [*Camptonectes*] *curvatus* (Gein.), P. [*Pseudamusium*] *obovatus*, *Sivaicus*, *Garudanus*, *Amusium sulcatellum*, *membranaceum* (Nilss.), and *illustre*. Of these two are of very general geographical distribution, known from Europe and many other countries; the others appear to be peculiar to the Indian cretaceous deposits.

Vola (vide Catalogue des *Janira*, in Pictet's Pal. Suisse, V^{me} ser., 4^{me} part., p. 251).

170-177.—*Vola Valangiensis*, Pict. et Camp., *V. atava*, Rœm., *Neocomiensis*, d'Orb., *Deshayesiana*, Math., *euryotis*, Pict. and Camp., *Royeriana*, d'Orb., *Morrisi*, Pict. et Renev., *Albensis*, d'Orb.

178-192.—*V. quadricostata*, Sow., *quinquecostata*, Sow. (see p. 437), *Fleuriausiana*, d'Orb., *lævis*, Drouet (see p. 438), *phaseola*, Lamck., *æquicostata*, Lamck., *dilatata*, d'Orb., *longicauda*, d'Orb., *cometa*, d'Orb., *digitalis*, d'Orb., *notabilis*, Münst., *alpina*, d'Orb. (see p. 438), *Carentonensis*, d'Orb., *hispanica*, d'Orb., *inconstans*, Sharpe.

193-203.—*V. gryphæata*, Schloth. (= *V. Faujasi*, Pict. and Camp., = *quadricostata* apud d'Orbigny), *Dutemplei*, d'Orb., *Truelli*, d'Orb., *sexangularis*, d'Orb., *decemcostata*, d'Orb., *striatocostata*,* Goldf., *substriaatocostata*, d'Orb., *Simbirkensis*, d'Orb., *podolica*, d'Orb., *Makovii*, Dubois, *Mortoni*, d'Orb.

204.—*V. Dresleri*, Drescher, (in Zeitsch. d. deutsch. geol. Gesellsch., xv, 1863, p. 354,) from near Lövenberg (Silesia).

205-206.—*Vola Dutrugei* and *tricostata* are described by Coquand from Algiers (Geol. et Paléont. Prov. Constantine, p. 219); the last is considered by Zittel to be identical with *gryphæata*.

207-211.—*V. duplicosta*, Rœm., *occidentalis*, Con., *quinquenaria*, Conr., *texana*, Rœm., and *Wrightii*, Shum., are peculiar to North America, and besides these *V. Mortoni* and *quadricostata* are recorded (see Meek in Check-list cret. inv. foss., Smiths. Misc. Coll., No. 177, p. 7).

212.—*V. grandicosta*, Gabb, Pal. Calif., II, p. 200.

213.—*V. alata*, Buch, (Petrif. rec. p. A. v. Humboldt, &c., p. 3,) is from the plateau of Quito.

214.—*V. Dufrenoyi*, d'Orb., (Voy. Am. Merid. Paléont., p. 106, pl. xxii, figs. 5—9), from Chili.

215.—*V. Syriaca*, Con., (Lynch's Exped., p. 230,) from Palæstine.

In South India only two species occur, *V. quinquecostata*, in very great variety, and *V. lævis* (*phaseola* apud d'Orbigny); both are known from Europe.

Hinnites (see Pictet's Pal. Suisse, V^{me} ser., 4^{me} part., p. 234).

I have already observed that considering *H. Cortesii* as the type of the genus, it appears probable that several of the very inequivalve fossil *Hinnites* with a thin shell will have to be transferred to *Hemipecten*.

216-224.—*H. Leymerii*, Desh., *Renevieri*, Coq., *Urgonensis*, P. and Camp., *Salevensis*, P. and C., *occitanicus*, Pict., *Favrinus*, P. and Roux, *Studerii*, P. and R., *Dujardini*, Desh., and *giganteus*, Guér.

225.—*H. Andoorensis* is the only species occurring in Southern India.

* Vide Favre in Descript. Moll. foss. de Lemberg, 1869, p. 156.

PECTEN, *Klein*, 1753, (see p. 424).

1. PECTEN ANAPAUDIENSIS, *Stoliczka*, Pl. XXXII, Fig. 1, & Pl. XL, Fig. 6.

1846. *Pecten obliquus*, Sow., apud Forbes, Trans., Geol. Soc., Lond., vii, p. 154 — non *idem* Sowerby.

P. testa ovata, paululum obliqua, inæquivalvi, valva sinistra convexiore, costis radiantibus fortioribus et (1-3) tenuioribus interpositis, squamose tuberculatis, ornata, valva dextra planiuscula, radiatim sub-æqualiter dense costata et concentrice squamose costellata.

This species is closely allied to the European *Pect. obliquus*, with which it was considered identical by Forbes, but it differs in the character of the ribs. On the left valve, which is somewhat more convex than the right, there are 1-3 thinner ribs between each two stronger ones, but they do not differ so much in strength as in *obliquus*. On the right valve the difference in the strength of the radiating ribs is still less marked, and the concentric lamellar striæ, or sharp ribs, are closer together than on the left one. The cast has only slight indications of the ribs.

In Forbes' original specimen (pl. xl, fig. 6,) the concentric striæ have become obsolete between the radiating ribs, and are indicated only by small scaly tubercles on them.

Locality.—East of Anapady, in a brownish sandstone.

Formation.—Trichinopoly group.

2. PECTEN RADULOIDES, *Stoliczka*, Pl. XXXI, Fig. 20, Pl. XXXII, Figs. 2—3, and Pl. XLII, Fig. 6.

Pect. testa oblique sub-orbiculari, postice lateraliter sensim dilatata, æquivalvi, valvis paulo convexiusculis, radiatim costulatis et concentrice sub-obsolete striatis, costulis lævigatis, sub-undulatis, in speciminibus junioribus æqualibus, depressiusculis, æquidistantibus, in adultis alteris tenuioribus interpositis, in declivitate postica fere omnino obsoletis; auriculis sub-æqualibus, postica valde obliqua, antica truncata, in valva dextra ad basin insinuata.

This is a very characteristic oblique species, in general form somewhat resembling a *Radula*, having the posterior side sensibly expanded. In young specimens the ribs are equidistant, smooth, depressed, and of equal strength; in older ones they alternate with thinner ribs, being always slightly undulating, and on the posterior declivity generally obsolete. As a rule, the ribs are equally well marked on both valves, but in some specimens they are a little less developed on the left, and when on this one the outer layer is not well preserved, they occasionally become hardly traceable (see fig. 3 on pl. xxxii). The species is closely allied to the European *P. undulatus*, apud Goldf., but apparently somewhat more oblique, not so wide, and with more distinct radiating striation. I can hardly believe that Goldfuss' species can be the same as that described by Nilsson in 1827 under the same name; the figures of both are entirely different.

Localities.—South-west of Mulloor, west and south-east of Arrialoor, near Karapady and near Veraghoor, in whitish or reddish sandstone.

Formation.—Arrialoor group.

3. PECTEN VERDACHELLENSIS, *Forbes*, Pl. XXXI, Figs. 13*—14,* Pl. XLII, Figs. 7-8.

1846. *Pecten Verdachellensis*, *Forbes*, Trans., Geol. Soc., Lond., vii, p. 154, pl. xiv, fig. 5—*idem* auctorum.

Pect. testa sub-orbiculari seu orbiculato ovata, æquivalvi, valvis lente convexiusculis, costulis et striis radiantibus, tenuibus, confertissimis, squamose spinulosis, ornatis, in valva dextra frequentioribus quam in sinistra; auriculis sub-æqualibus, radiatim costulatis.

A very densely radiately costulated, sub-orbicular species, the ribs being unequal, often sub-divided and covered with very numerous, fine, spinulose scales; they are generally on the right valve more numerous and often also thinner than on the left one; the concentric striæ are only at certain distances somewhat better marked.

Localities.—Ootatoor, Puravoy, Moraviatoor, in brownish earthy limestone.

Formation.—Ootatoor group.

4. PECTEN ARCOTENSIS, *Stoliczka*, Pl. XXXI, Figs. 18—19.

Pect. testa ovato-orbiculata, antice paululum dilatata, æquivalvi, valvis costulis radiantibus crassulis, simplicibus, interdum minoribus indistinctis alternantibus, et concentricis striis acutis, confertis, in costulis squamulosis, ornata; auriculis anticis paululum majoribus, radiatim costellatis, posticis minoribus, obliquis.

This differs from the previous species by its comparatively much stronger costulation and slightly more oblique shape.

Locality.—Strípermatúr, in a ferruginous conglomeratic sandstone.

Formation.—Arrialoor group.

5. PECTEN [CHLAMYS] ASPERULINUS, *Stoliczka*, Pl. XXXI, Figs. 10—11, Pl. XLIV, Fig. 5.

Pecten testa sub-orbiculari, æquilaterali, valvis modice et fere æqualiter paululum convexiusculis, radiatim 11-15 costatis, costis latis, sulcis profundis angustissimis separatis, medio maxime elevatis, tuberculis squamosis aut sub-spinosis ornatis, in utraque declivitate 3-4- costulatis, costulis inæqualibus, confertissime squamulosis, costula prima ad cristam medianam sita tenuissima, secunda fortiore, tertia tenui aut obsoleta, quarta, seu infima, fortissima; auriculis sub-æqualibus, modicis, radiatim costulatis, truncatis, antica valvæ dextræ ad basin emarginata.

This species may be said to represent the common European *Pecten asper* in India; it is very closely allied to it, but the lateral ribs on the slope of each large rib are somewhat different. In *asper* the one next to the median tuberculated crest is the strongest, or it is separated from it by only a very thin rib; in *asperulinus* the last rib adjoining the median furrow is the strongest. The scales are on the secondary ribs of the Indian species very thin, and numerously crispate.

* In these figures the radiating ribs are a little too strongly marked; they should be thinner and more unequal; their character is well shown in the enlarged view (fig. 14 b) of a portion of well preserved surface.

Similar differences also apply in a comparison with other allied species, as for instance, *P. Dujardini*, Rœm., *rarispinus*, Reuss, and one or two others described by Goldfuss.

The ornamentation of *asperulinus* is, however, very variable on account of the scales being easily broken off. The median tubercles are often quite worn away, and the lateral ribs become more or less indistinct, except the two lowest (comp. fig. 10 on pl. xxxi), which are seated in the cavity between the ribs.

Localities.—Near Kaudoor, in a white conglomeratic sandstone, and near Chokanadapooram, in a whitish soft limestone.

Formation.—Arrialoore group.

It deserves to be noticed that in the Ootatoor limestone at Cooticaud there occurs another still larger species, probably belonging to the sub-genus *Chlamys*. It is apparently a little higher than *Pecten depressus*, Münst., (Goldfuss, Petræf. Germ., pt. ii, p. 53, pl. 92, fig. 4). The ribs are broad, carinate in the middle, with a few radiating striæ at the sides, and one more distinct in the groove separating each two large ribs. None of the specimens are, however, sufficiently perfect to define the exact form of this interesting species.

6. PECTEN [CAMPTONECTES] CURVATUS, Geinitz, Pl. XXXI, Figs. 15—16.
Pl. XLI, Figs. 4—6.

1827. ? *Pecten arcuatus*, Sow., apud Nilsson, Petrif. Suec., p. 22, pl. ix, fig. 14, non *idem* Sowerby.
1843. „ *curvatus*, Geinitz, Kieslingsw., p. 16, pl. iii, fig. 13; et 1848, Quadersandst., p. 180.
1845. „ *virgatus*, Nilss., apud d'Orbigny, Pal. franç. terr. cret., iii, p. 602, pl. 434, figs. 7-10, non *virgatus*, Nilsson.
1846. „ *virgatus*, Nilss., apud Forbes, Trans., Geol. Soc., Lond., vii, p. 154, pl. xv, fig. 22.
1846. „ *arcuatus*, et ? *divaricatus* apud Reuss, Böhm. Kreidef., pt. ii, pp. 27 and 28, pl. xxxix, figs. 6 and 7.
1850. „ *subvirgatus*, d'Orbigny, Prod., II, p. 253.
1866. „ *virgatus*, Nilss., apud Zittel, Denksch. Acad., Wien, xxv, pt. ii, p. 109, pl. xvii, fig. 8, (haud *synon. omnibus*).

P. [Camp.] testa sub-orbiculare ovata, prope apicem sensim angustata, sub-æquivalvi, valva sinistra paululum convexiore, utraque radiatim confertissime striatocostellata, costellis depressis, in valva dextra tenuioribus quam in sinistra, excurvatis, plurime dichotomis, lineis impressis multo angustioribus, punctatis, separatis, et striis incrementi concentricis minutis intersectis; auriculis radiatim striatis aut costellatis, inæqualibus, postica minore, oblique truncata, antica majore, in val. dextra ad basin profunde insinuata.

The right valve is in this species always somewhat flatter, and the radiating striæ are, as a rule, finer on it than on the left valve; the ears are marked with oblique transverse striæ, which become on the anterior ear of the right valve mostly obsolete, being replaced by concentric arcuate striæ. Zittel published a few years ago a long account of the synonymy of *Pecten virgatus*, Nilsson, but his discrimination of the various forms does not seem to be always correct. I shall briefly notice the history of the present species and of *virgatus*.

Nilsson appears to have been the first to distinguish two species of very similar, roundly ovate, shape; the one with numerous arcuate striæ or ribs, and the other with a much smaller number of very similar ribs; the former* he identified with Sowerby's *P. arcuatus*, (which is a jurassic species), and the latter he named *P. virgatus*.

Omitting some doubtful references of various authors to Nilsson's supposed *arcuatus*, we find the species again under Geinitz' name *curvatus*, and shortly afterwards d'Orbigny figured and described it in his Pal. franç. under the name of *virgatus* of Nilsson. Forbes, when noting the Indian form, very probably based his identification upon d'Orbigny's figure, and in so far was quite correct, but that figure represents Geinitz' *curvatus* and not Nilsson's *virgatus*. Reuss recorded a right valve of this species under the old name *arcuatus*, and a left one, to all appearance belonging to the present species, he called *divaricatus*. Geinitz in his "Quadersandstein-gebirge" very properly separates his *curvatus* from true *virgatus*, but his reference to the synonymy of the latter species is not correct, as I shall note further on. D'Orbigny, when suggesting the name *sub-virgatus* for the Indian form, justly remarks that it differs from Nilsson's *virgatus* by much finer ribbing. This difference equally applies to the form described by Zittel from the Gosau deposits under Nilsson's name.

Zittel complains of the want of accuracy in Nilsson's original figure of *virgatus* for which there is no reason, because that species is always much coarser ribbed than *curvatus*, even allowing for the slight difference in the ribbing of the two valves of the latter species, a character which should never be overlooked. Goldfuss' *arcuatus* from Aachen is undoubtedly the same species as Nilsson's *virgatus*, as I have had opportunity of comparing original specimens from those localities. It is the only reliable record of true *virgatus* I know of; most of the other references quoted under *virgatus* probably belong to *curvatus*.

Localities.—Arrialoer and Kaudoor, in whitish sandstone, (Arrialoer group); north of Garudamungalum, and near Veraghoor, in a bluish and grey sandstone (Trichinopoly group); rare.

Formations.—Arrialoer and Trichinopoly groups. There is no difference to be observed between the specimens from the two series of beds.

In Europe the species occurs in the senonien beds near Aachen, in the lower and middle Plæner of Saxony and Bohemia, in the Gosau deposits of the Austrian and Bavarian Alps, in the Turonien in France, &c. It is not, however, reliable to refer to foreign localities, because the distinction between *virgatus* and *curvatus* has not always been noticed. Coquand records *virgatus* from his "étage Mornasien" (? = Turonien) from the Province Constantine (Paléont., p. 299), and as he

* Reuss (Bohm. Kreide., 1846, pt. ii, p. 28, pl. xxxix, fig. 8.) identifies this form with one from Bohemia under the new name *P. concentrice-punctatus*, which is nearly circular, and, as regards shape, therefore, very different from Nilsson's figure of his supposed *arcuatus*. I doubt that both are the same, in spite of Nilsson's statement that the shell of his species is very thin, resembling that of *Amus. membranaceum*, for the thickness of the valves varies greatly both in true *virgatus* and in *curvatus*, and the right valve is often a little thinner than the left one.

quotes Nilsson's original figure of that species, it is perhaps true *virgatus*. The form described as *virgatus* by Römer from Texas (Kreidebild., p. 66,) does not exhibit any appreciable difference from *curvatus*, but was called *Texanus* by Gabb.

7. PECTEN (SYNCYCLONEMA) OBOVATUS, *Stoliczka*, Pl. XXXII, Figs. 6—9.

P. [Sync.] testa ovata, apice acutata, æquivalvi, valvis paululum convexiusculis, aut sub-lævigatis, aut concentrice lamellose striatis, auriculis parvis, æqualibus, lateraliter valde declivibus.

This species is somewhat allied to *Amusium membranaceum*, Nilss., and also to *Pseudam. laminosum*,* Mant., but differs from both by the comparatively smaller size of the ears, which are equal and very oblique at the lateral margins.

In well preserved specimens the surface is marked with concentric lamellar equidistant striæ, exactly as in *laminosum*, but these striæ are very easily worn off, and in such specimens the surface becomes nearly quite smooth. The upper lateral margins of the shell meet at the beak with an angle of 98°.

Localities.—Ootatoor, Moraviatoor, north and north-east of Odium, south of Puravoy, &c., in brownish earthy limestone.

Formation.—Ootatoor group.

8. PECTEN [SYNCYCLONEMA] SIVAICUS, *Stoliczka*, Pl. XLII, Fig. 5.

P. [Sync.] testa orbiculate ovata, parum convexa, tenui, lævigata, polita, apice breviter acutata, auriculis sub-æqualibus, postica oblique desinente, antica convexe truncata, ad basin paululum insinuata.

Easily distinguished from the last species, which it closely resembles in form, by the different shape of the ears, the anterior being convexly truncate and slightly insinuated at the base.

Locality.—North of Odium, in brownish earthy limestone; apparently very rare.

Formation.—Ootatoor group.

9. PECTEN [PSEUDAMUSIUM] GARUDANUS, *Stoliczka*, Pl. XXXII, Fig. 4.

P. [Pseudam.] testa sub-orbiculari, antice paulo latiore quam postice; valvis complanatis medio et ad apicem parum convexis, tenuissimis, striis incrementi subtilissimis notatis; auriculis magnis, fere æqualibus, antica convexe truncata et ad basin paulo emarginata.

This species differs from the last by the more orbiculate shape and somewhat smaller convexity of the valves; the ears are of similar form, but comparatively still larger. The shell is very thin and only marked with very fine, concentric striæ of growth.

Localities.—East of Anapaudy and near Veraghoor.

Formation.—Trichinopoly group.

* This is considered by Morris as identical with *Pecten orbicularis*.

AMUSIUM, *Klein*, 1753, (see p. 426).1. AMUSIUM ? MEMBRANACEUM, *Nilsson*, Pl. XXXII, Fig. 5, and Pl. XLI, Figs. 7-8.1827. *Pecten membranaceus*, Nilss., Petrif. Suec., p. 23, pl. ix, fig. 16.1866. *Idem*, Zittel, Denksch. Akad., Wien, xxxv, pt. ii, p. 107, cum. syn.

Am. testa ovato-orbiculari, æquivalvi, valde complanata, sub-æquilaterali, tenuissima, lævigata aut concentrice subtiliter striata, nitida; auriculis fere æqualibus, postica oblique desinente, antica subtruncata.

The Indian specimens do not exhibit any difference from the European ones. The superficial glassy layer is, as a rule, quite smooth, but when it has been removed by decomposition, the shell exhibits a number of very fine radiately arcuate lines. The gape of the valves must be very slight, if indeed it is at all marked, but the structure of the shell appears to be that of *Amusium*.

Localities.—Arrialoore and Karapaudy, in grey sandstone; rare.

Formation.—Arrialoore group.

In Europe this species belongs to one of the commonest shells in the upper and middle (Turonien) cretaceous beds; it has been recorded from Sweden, Hanover, at Maastricht, from near Aachen, in Saxony, Bohemia, at Lemberg (in Galicia), in the Alpine Gosau deposits of Lower Austria, in Bavaria, &c.

2. AMUSIUM ILLUSTRE, *Stoliczka*, Pl. XLI, Figs. 9.

Am. testa magna, sub-orbiculari, valvis convexiusculis, crassis, ad umbones late obtusatis, lævibus, striis incrementi inæqualibus, partim sub-obsoletis tectis; auriculis sub-æqualibus, magnis, oblique truncatis.

One of the largest known cretaceous species of the genus, distinguished by a strong, solid, almost smooth shell, obtuse umbones, and considerable convexity of the valves; the ears are large and apparently very nearly equal. The valves appear to have been slightly gaping at both ends.

Locality.—West of Arrialoore, in light grey sandstone.

Formation.—Arrialoore group.

3. AMUSIUM SULCATELLUM, *Stoliczka*, Pl. XXXI, Figs. 12 and 17.1846. *Pecten orbicularis*, Sow. ? apud Forbes, Trans., Geol. Soc., Lond., vii, p. 154, non *idem* Sow.

Am. testa sub-orbiculata, valvis crassiusculis, æquilateralibus, parum convexis, ad latera deplanatis, concentrice sulcis angustis aut lineis impressis subdistantibus, concentricis, confertis, notata, æquidistantibus, lateraliter minus distinctis, interstitiis planatis, sulcis multo latioribus, concentrice minutissime striolatis; auriculis sub-æqualibus, postica paulo minore, oblique et sub-flexuose terminante, antica majore, rectius truncata.

A sub-compressed, nearly orbiculate species of the type of *A. orbiculare*, Sow., but with somewhat more acute umbones and much thicker shell. The ornament-

ation very much resembles that of *Am. cretaceum*,* Nyst, (= *Pect. corneus* apud Nilss., non *idem* Sowerby), the surface being marked with impressed, concentric lines or grooves, about one millimetre distant from each other; the interspaces are flat and also very finely concentrically striated; at the sides of the valves both striæ and grooves generally become indistinct or obsolete. The posterior ear is slightly smaller, and has a very oblique, slightly flexuous, margin; the anterior is a little larger and more truncate; both are marked with concentric striæ of growth. The concentric grooves are traceable also on the inner side of the valves.

Locality.—Near Arrialoór, in a light grey sandstone.

Formation.—Arrialoór group.

VOLA, Klein, 1753, (see p. 426).

1. VOLA QUINQUECOSTATA, Sowerby, Pl. XXXI, Figs. 1—6, and Pl. XXXVII, Figs. 4—9.

1814. *Pecten quinquecostatus*, Sowerby, Min. Conch., I, p. 121, pl. 56, figs. 4-8 — *idem* auctorum.

1819. *Pecten versicostatus*, Lam., An. s. vert., vi, p. 181.

1843. *Janira quinquecostata*, d'Orbigny, Pal. franç. terr. cret., iii, p. 632, pl. 444, figs. 1—5.

1846. *Pecten quinquecostatus*, apud Forbes, Trans., Geol. Soc., Lond., vii, p. 153.

1847. *Janira Fontanieri*, d'Orb., Voy. Astrolabe, &c., Paléont., pl. iv, figs. 38—40.

Vola testa ovato sub-trigona, clausa; valva dextra valde convexa, radiatim costis 6 majoribus, ad marginem plus minusve projicientibus, 4, 3, aut rarissime 2, costulis minoribus, sub-æqualibus vel inæqualibus interpositis ornata, declivitate antica et postica striis 4-5 radiantibus notata; valva sinistra plana aut paulo concava, similariter costata; utraque striis concentricis, filiformibus, confertissimis tecta, auriculata, auriculis sub-æqualibus, radiatim striatis, auricula postica paululum majore quam antica.

In referring a great number of Indian specimens to this well known European species, it is necessary to state the variations which are to be observed in them and to draw attention to the numerous figures representing them.

The most characteristic forms of *V. quinquecostata* occur in a yellowish soft marly rock south-west of Coonum; they nearly all possess four intermediate ribs between each larger one, and the two median of the four are again somewhat thicker than the two lateral ones. Exactly similar forms also occur north of Odium, at Ootatoor, and south of Puravoy, south-east of Permapolliam (Trichinopoly group), and near Arrialoór (Arrialoór group), but at all these localities the typical form does not appear so common as some varieties. At Odium, Moraviatoor, and Ootatoor there occur specimens which often grow to a considerably larger size than at Coonum, and in these there are, as a rule, only three smaller ribs between each two larger ones, except between the two posterior larger ribs, where there are almost invariably four smaller ribs present. This variety also occurs at Permapolliam, Anapady, Serdamungalum, and Arrialoór; therefore in

* Coq. et polyp. foss. de terr. ter. de Belgique, 1843, p. 299.

all three divisions of the South Indian Cretaceous deposits. Again, some other specimens have between the first and second, or between the second and third, anterior larger ribs four intermediate ones; very rarely is it the case that only two intermediate ribs occur in one or the other of the interspaces between the larger ribs. I only observed it in a few specimens from Odium (see fig. 8, pl. xxxvii); they are also all of large size. Three intermediate sub-equal ribs (*V. quadricostata*) are only met with in some small specimens from Arrialoor and Shillagoody.

I have compared a very large series of specimens from various localities and formations, and I am confident that the Indian shell *does not* admit any such distinction, as has been proposed for *V. quinquecostata* and *quadricostata* (= *gryphaeata*); the former said to possess always four and the latter always three intermediate ribs. The different variations are not restricted either to particular localities, or to distinct formations; they occur without any rule one among the other. The only thing which could be said is, that specimens from the Ootatoor group have more commonly four and those from the Arrialoor group more commonly three intermediate ribs. I also could find no perceptible difference in the form and striation of the ears of the various Indian specimens. The state of preservation has a great deal to do with the relative size of the ribs and is often very misleading.

I do not wish to pronounce a certain opinion as to the identity of *V. quinque-* and *quadricostata*, but I cannot help doubting their specific distinction. The support which d'Orbigny gave to his opinion, by placing the one shell in the Turonien and the other in the Senonien, has been long ago disproved: such geological restriction does not exist; both forms occur from the Tourtia and Cenomanien up into the upper beds of the white chalk.

I have no specimens of d'Orbigny's *V. æquicostata* and *alpina* to compare, but judging from the observations which I made on the Indian specimens, I doubt that even these two will prove to be distinct species from *quinquecostata*, though certain varieties may be locally constant.

Localities.—North of Odium, Cullapaudy, Moraviatoor, Ootatoor, south of Puravoy, (Ootat. group); south-east of Permapolliam, east and north-east of Anapaudy; south of Serdamungalum, (Trichinopoly group); east and west of Arrialoor; south-east of Mulloor, Shillagoody, and Olapaudy (Arrialoor group).

Formations.—Ootatoor, Trichinopoly, and Arrialoor groups.

2. VOLA LÆVIS, Drouet, Pl. XXXI, Figs. 7-8.

- 1824. *Janira* (? *Neithea*) *lævis*, Drouet, teste Pictet et Campiche, Pal. Suiss., V^{me} ser., 4^{me} part., p. 252.
- 1843. *Janira phaseola*, apud d'Orbigny, Pal. franç. terr. cret., iii, p. 635, pl. 444, figs. 6-9; *eadem* aut *Neithea phaseola* auctorum, non *eadem* Lam.
- 1846. *Pecten decipiens*, Reuss, Böhm. Kreidef. pt. ii, p. 31, pl. 45, fig. 3.
- 1868. *Pecten phaseolus*, apud Gümbel, Abhandl. math. Ph. Klasse, Bayer. Akad. Wissensch., x, p. 564.

Vola testa late sub-ovata, crassula, apice angustata, paululum obliqua, valva dextra convexa, radiatim sub-costata, costis paululum convexiusculis, latis, æqualibus, lineis impressis disjunctis; valva sinistra plana, radiatim costata, costis angustis

sub-æqualibus, sulcis fere duplo latioribus separatis; utraque valva concentrice minute striata, biauriculata, auriculis sub-æqualibus, postica majore, et ad marginem obliquiore.

The ribs on the convex valve are generally very indistinct, but in well preserved specimens they always are slightly convex; they are 22-24 in number, separated by very fine impressed lines; as a rule, they are equally strong, but occasionally one or two exceed others in breadth. On the left or flat valve the ribs are more prominent, separated by broader furrows, which on the inner side appear as many broad and flat ribs; this character easily distinguishes the flat valves of the present species from those of *quinquecostata*, even when the extreme margin of the shell is not well preserved. I have accepted the name *lævis*, Drouet, for the present species, following in this identification Pictet and Campiche, who consider Lamarck's *phaseola* as a distinct species. I am not acquainted with Drouet's original description.

Localities.—Near Kullay, Coonum, Odium, and Koloture.

Formation.—Ootatoor group.

This species occurs in the Cenomanien of France.

HINNITES, Defrance, 1821, (see p. 427).

1. HINNITES ANDOORENSIS, Stoliczka, Pl. XXXII, Fig. 10.

H. testa late ovata, sub-æquilaterali, antice parum dilatata, inæquivalvi, valva convexa radiatim multicostata, costis fortioribus, una, vel duabus, aut tribus, tenuioribus alternantibus, striis concentricis acutis decussatis, aliquando spinulose sub-tuberculatis; valva dextra plana, radiatim obsolete in-æqualiter costulata ac concentrice striata; auricula antica magna, ad basin profunde insinuata.

Shell ovate, with the anterior side somewhat dilated; the left valve is considerably convex, ornamented with stronger and thinner radiating ribs, crossed over by concentric, sharp striæ, by which the ribs become somewhat undulating, especially towards the margins. The right valve is quite flat, and the radiating ribs on it much less distinct.

Locality.—Near Andoor, in an earthy, brownish limestone.

Formation.—Ootatoor group.

XLIII. Family,—SPONDYLIDÆ.

The animals have the mantle margins usually thickened, consisting of two or three laminæ, unequally cirrated at the edge, often with a few larger filaments between them; numerous small ocelli are placed at short distances from each other at the base of the internal cirrhi; mouth surrounded by a large foliaceous lip, to which laterally the palps are attached, being of an oblong, terminally pointed shape; gills large, fleshy, equal or sub-equal, posteriorly somewhat similarly curved as in *Avicula*, and free; foot small, cylindrical, somewhat thickened at the end,

or obliquely truncate. In *Spondylus* occasionally there issues from the middle of the terminal disc of the foot a cylindrical tendon, ending in a fleshy mass. In some of the eastern species of this genus the foot is simply thickened a short distance from its base on account of the development of the byssal gland; the latter has a slight groove, and sometimes a few thick, foliaceous byssal threads are seen to issue from it, but, as a rule, the *Spondyli* do not appear to spin a byssus. The animal of *Pedum*, however, always possesses a short byssus, composed of thin threads.

The shells are always inequivalve, the right valve being, as a rule, somewhat larger, more or less attached at the beak, which is often irregularly produced and on the inner side possesses a flattened area; the left valve is free, generally smaller and also with a smaller hinge area; both are more or less distinctly eared; the cartilage is internal, situated in a median pit; the hinge is toothless or provided with rib-like or tubercular teeth on either side of the cartilage pit, muscular impression subcentral, rounded, more or less confluent with the posterior pedal muscle, which is attached to the inner part of it; anterior pedal scars sometimes indicated below the beak, but generally not traceable; pallial line entire; surface generally ornamented with radiating, often foliaceous ribs and striæ; inner layer of shell thick, more or less glassy.

In the general habitus the *SPONDYLIDÆ* more resemble the *PECTINIDÆ* than the *RADULIDÆ*, differing from the former by their more or less sessile habitat, thickness of shell, and by the usual presence of hinge-teeth; from the latter principally by the inequality of the valves, internal ligament, and by the presence of ocelli at the inner mantle margins.

In former geological periods the members of this family were not very numerous; they only appeared with the beginning of the mesozoic epoch, but it is difficult to say whether they attained their maximum of development towards the close of this epoch or not, at least as far as *Spondylus* is concerned, though this was very likely the case, as it certainly was with *Plicatula*. *Terquemia* is only known fossil, and *Pedum* only recent from a single species. The recent forms are with very few exceptions inhabitants of tropical seas; they are found mostly in the littoral zone, more rarely at greater depths.

1. *Plicatula*, Lam., 1801. Valves radiately plicated, right valve more or less largely attached at the beak, which has often a small thickened free area, beaks with indistinct, in advanced age generally quite obsolete, ears, left valve somewhat smaller, and usually with a more pointed beak; hinge with two strong, laterally more or less distinctly striated teeth, interlocking between each other, and a cartilage groove, or pit, between them; muscular impression single, large, generally well marked, excentric, pallial line entire, distant from the margin; type, *P. plicata*, Forsk. Some of the recent as well as fossil species have barely a trace of attachment at the beak of the right valve.

1a. Deslongchamps, in an elaborate paper on the liassic and jurassic *Plicatulae*, has pointed out some peculiarities of a certain number of species for which he

retained Parkinson's name *Harpax* (1811), but I do not think that the distinction is really a generic one; (Essai s. les Plic. foss., &c., Mém. Soc., Linn. de Norm., 1859, XI, p. 1 et seq.). The general character and structure of the shell is in both essentially the same, the hinge-teeth in *Harpax* always extend up to the beak, the ligamental pit is in the right, or attached, valve at the end of a strong median rib, and in the left valve it is very slightly marked, while in *Plicatula* there is usually a small space between the beak and the hinge, separating the teeth from the beak itself, and the ligamental pit in the left, or free, valve is conspicuously deepened. Besides that the hinge-teeth of *Harpax* are generally stronger and more parallel, and the shells are often of large size. It may be thought convenient to retain the name *Harpax* sub-generically for such characteristic forms as *H. Terquemi*, Eud.-Desl., but as the left or free valve of some recent *Plicatula* offers characters of the hinge-teeth which are nearly identical with those of *Harpax*, it would not be justifiable to recognise the latter as a separate genus.

1b. In the above quoted paper (p. 113 et seq.), Eudes-Deslongchamps distinguished among the mesozoic *Plicatula* a peculiar section under the name *Pl. reticulata*. They are sessile with the greater part of one valve, of a semi-circular shape, and the inner surface is always peculiarly striated and reticulated. The hinge areas of both valves are obliquely descending, and there appears to be a median ligamental pit present, but whether for the attachment of a ligament or not is uncertain; no hinge-teeth, nor a pallial line, or muscular scars, have as yet been observed in these fossils, and it is, therefore, difficult to say whether they really are Pelecypoda or not. They no doubt represent a special genus, of which *Pl. retifera* is the type.

Eichwald proposed for somewhat similar shells the name *Cyclostreon*, which I shall notice in the *Anomiidæ*.

1c. Laube (Denksch. Akad., Wien, vol. xxv, pt. ii, p. 75,) describes from the Trias of St. Cassian a peculiar smooth species, *Pl. solea*, which on one (? posterior) side has a distant, double, lateral tooth near the margin. The valve described is apparently the right one. The hinge-teeth are very close together, leaving only a narrow groove for the ligament. It is probable that this species indicates a new generic type.

Species of *Plicatula* are known from the Trias upwards; they are always found in small numbers; their largest development probably falls in the middle part of the mesozoic period. At present there are only about twelve species known from Eastern and American seas.

2. *Spondylus*, Klein, 1753, (Ostrac., p. 136, pl. ix, No. 37; Linné, 1757). Valves very unequal, the lower, or right, more or less attached to foreign bodies, with a flattened area between the beaks and the hinge; upper valve smaller, with distinct ears and a smaller, sometimes obsolete, hinge area; hinge line generally straight, more or less thickened; hinge with a median, deep, usually well circumscribed, cartilage pit and a strong tooth on either side, with corresponding cavities in the other valve; muscular scar sub-central, large; the inner portion of it is

probably produced by the posterior branch of the pedal muscle, which appears to be confluent with the impression of the adductor; pallial line entire; surface of valves always radiately ribbed and often spinose; type, *Sp. gæderopus*, Linné.

Fossil species are known from the Lias* upwards, gradually increasing in number and attaining their maximum of development in the present seas. The few species noted from triassic and older deposits are doubtful; some of them appear to indicate new generic forms, and others have already been transferred to *Hinnites*. The attachment of the right valve is in some recent and fossil species very small, and in a few it becomes quite obsolete. When the young *Spondyli* find a suitable place on a solid dead rock they generally become firmly attached, but when they are seated on living coral they become in time quite free, and are found generally placed in an open cavity on the surface of coralline masses. I have myself collected several such specimens on the reefs at Singapore and near the Andaman and Nicobar Islands.

2a. As a probable new generic form I must mention a peculiar species, *Spondylus pulvinatus*, described by Zittel from the Gosau deposits (Denksch. Akad., Wien, xxv, pt. ii, p. 119, pl. xviii, fig. 8). It is a small remarkably thick, transversally ovate shell with a very strong straight hinge line, possessing the external hinge teeth of a *Spondylus*, but having the cartilage placed in two pits one beside the other. It is most probable that this species belongs to a genus different from *Spondylus*, but as there has been as yet only a single valve found, I shall not venture for the present to propose a new name for it.

Deshayes has shown that the names *Podopsis*, *Pachytes*, and *Dianchora* have been based merely upon cast, or imperfect, specimens of *Spondyli*. In the case of *Dianchora*, Sow., the beak of the right or attached valve appears to have been broken off, and the opening produced by this break was evidently considered as naturally belonging to the shell.

3. *Pedum*, Brug., 1792. Valves generally higher than long, slightly convex, with a striated triangular area between the beak and the hinge line, smaller in the left valve than in the right, or larger, valve; the latter has a deep incision in front of the hinge line; ligament situated in a groove, which passes through the median portion of the area and terminates internally with a projecting cartilage process; hinge edentulous, muscular scar faint, large, sub-central, roundish, partially confluent with the pedal scar; pallial line entire, faint; type, *P. spondyloideum*, Gmel., being the only species as yet known from the eastern seas.

Deshayes censures H. and A. Adams' classification of this genus and places it near *Pecten* on the ground that the right valve is free. It is not more free than in many *Spondyli*, and is found resting on corals with the right valve in exactly similar manner as these do, the consequence being that the radiating striæ are generally not developed on the right or larger valve, which also often remains

* Eud-Deslongchamps has described a few species from these beds, but the hinge-teeth do not as yet appear to have been observed in them. The oolitic species described by the same author, however, bear all the external characters of typical *Spondyli*.

white, while the smaller valve, exposed to light, is colored. The large development of the hinge area, with the ligamental groove passing through it, and the structure of the shell of *Pedum*, undoubtedly show greater affinities to the *Spondyli*, than they do to the *Pectines*.

4. *Terquemia*, Tate, 1867, (Suppl. to Woodward's Manual of Mollusca, *Carpenteria*, Deslongchamps, 1859, Mém. Soc., Linn., Norm., xi, p. 120—non *eadem*, Gray, 1856). Valves radiately ribbed, externally lamellar, internally porcelainous, rounded, generally somewhat irregular; right valve larger, attached, usually somewhat convex, left valve somewhat smaller and also flatter; hinge area well developed in both valves, striated, with a ligamental groove passing through it and slightly projecting internally, terminating with a roundish hole; no hinge-teeth; muscular scar rounded, somewhat posteriorly placed, excentric, pallial line indistinct; type, *Terq. pectiniformis*, E.-Desl., from the lias. Only a few other jurassic species have been made known. The classification of the genus in the present place must be considered as provisional, for the shells are extremely like *Ostrea*, but the hinge area and the ligamental groove appear to me to have their nearest analogues among the *SPONDYLIDÆ*, and the shells themselves show a great similarity to *Plicatula*.

LIST OF CRETACEOUS SPECIES.

1. *Plicatula asperrima*, d'Orb., Pal. franç. terr. cret., iii, p. 679, pl. 462, figs. 1—4.
- 2-5.—*P. Carteroniana*, d'Orb., (*ibidem*, p. 680), *Ræmeri*, d'Orb., (*ib.*, p. 681; = *armata*, Rœm., non Goldf.), *placunea*,* Lam. (*ibid.* p. 682; = *Spondylus strigilis*, Brong.), *radiola*, Lamck., (*ibid.* p. 683; = ? *pectinoides*, Sow.).
- 6.—*P. radiata*, Goldf., Petr. Germ., ii, p. 102, pl. 107, fig. 7.
- 7.—*P. nodosa*, Duj., Mém. Soc. Geol. Fr., 1837, ii, p. 228, pl. 15, fig. 14.
- 8.—*P. inflata*, Sow., (*vide* Mat. Pal. Suisse.—Foss. de la Perthe du Rhone, &c., par Pictet et Renevier, 1858, p. 137; = *P. spinosa*, Mant., (Geol. of Suss., p. 26, figs. 13, 16-17; non *eadem* Sow., sed *eadem* d'Orbigny, Pal. franç. cret., iii, p. 685; teste Coquand, Monog. Étage Apt. de l'Espagne, p. 159).
- 9.—*P. gurgilis*, P. and Roux, Foss. des Grés verts, 1849-53, p. 517.
- 10.—*P. imbricata*, Koch et Dunk., Beitrage, &c., 1837, p. 50, pl. 6, fig. 3.
- 11.—*P. inæquidens*, Sharpe, Quart. Journ. Geol. Soc., Lond., x, p. 197, pl. 6, fig. 3.
- 12.—*P. deltoidea*, Tate, Quart. Journ. Geol. Soc., Lond., xxi, p. 39, pl. 3, fig. 5.
- 13.—*P. aspera*, Sow., (*vide* Zittel in Denksch. Akad., Wien, xxv, pt. ii, p. 120, pl. xix, fig. 1, and for further reference p. 446). Fraas (Würt. Jahresh., xxiii, p. 232,) quotes the species also from Palæstine.
- 14-18.—*Pl. affinis*, Eichw., *P. aurita*, Trautsch., *P. convexa*, Eichw., *P. rudis*, Eichw., et *P. lamellosa*, Eichw., are all stated to occur in Neocomien rocks of Russia (see Leth. ross., xme livr., p. 413, et seq.).
- 19.—*P. Arachne*, Coquand, (Mon. Étage Apt. de l'Espagne, 1865, p. 160).
- 20.—*Plicatula arachnoidea*, Desl., Mem. Soc., Linn., Norm., xi, p. 124, belongs to a peculiar genus probably allied to *Cyclostreon* of the *ANOMIIDÆ*.
- 21-22.—*Pl. clathrata* et *delta*, Deslongch. (Mém. Soc., Linn., Normandie, xi, p. 104, pl. 17, figs. 9-10 and 11-12). The second species is considered doubtfully cretaceous.

* Coquand (Monog. Étage Aptien de l'Espagne, 1865, p. 158), unites *asperrima*, d'Orb., also with this species.

23.—*Pl. Malberchiana*, Coq., (Bull. Soc. Géol., France, xvi, 1859, p. 1003).

24-30.—*Pl. Fourneti*, *Ferryi*, *Flattersi*, *Auressensis*, *Reynesi*, *Desjardinsi* and *decipiens* are described by Coquand from Algiers, (Geol. et Paléont. Prov. Constant., 1862, p. 220 et seq.).

31.—*P. urtica*, Mort., (Synops. cret. foss., North America, p. 62, pl. 10, fig. 2).

32.—*P. incongrua*, Con., (Emory's Rep., p. 153, pl. 6, fig. 10).

33-34.—*P. Saffordi* et *tetrica*, Con., (Journ. Acad. Nat. Sc., Phil., 2nd ser., iv, p. 283, pl. 46, figs. 34 and 26).

35.—*P. variata*, Gabb, (Pal. Calif., i, p. 303, pl. 26, fig. 190).

36-40.—*Pl. striatocostata*, *instabilis*, *multicostata*, *sessilis* and *septemcostata* occur in the South Indian cretaceous deposits.

Spondylus (see Pictet' Pal. Suisse, V^{me} ser., 4^{me} part., p. 260).

41-50.—*Sp. Rœmeri*, Desh., (= *latus*, Desh. et *hystrix* apud Rœmer), *striatocostatus*,* d'Orb., *bellulus*, Lor., *cancellatus*, Guem., *complanatus*, d'Orb., *gibbosus*, d'Orb., *Renauxianus*, d'Orb., *dichotomus*, Buv., *striatus*,† Sow., *Requienianus*,† Matheron.

51-60.—*Sp. hystrix*, Goldf., *latus*, Sow., *fimbriatus*, Dixon, *obesus*, d'Orb., *Coquandianus*, *hippuritarum*, and *alternatus*, d'Orb., *spinosus*, Sow., *truncatus*, Goldf., *Carentonensis*, d'Orb.

61-70.—*Sp. Santonensis*, *globulosus*, *Royanus* et *Dutempleanus*,‡ d'Orb., *æqualis*, Heb., *Aonis*, d'Orb., *obliquus*, Mant., *Brightoniensis*, Mant., *lineatus*, Goldf., *undulatus*, Rss.

71-75.—*Sp. Hagenovi* and *asper*, Münster., *armatus*, Goldf., *subplicatus* and *sublævis*, d'Orb.

76.—*Sp. pulvinatus*, Zittel (Denksch. Akad., Wien, xxv, pt. ii, p. 119), is from the Austrian Gosau deposits.

77-78.—*Sp. tauricus* et *pygmaeus*, Eichw., (Leth. rossic., x^{me} livr., 1867, p. 419 et seq.).

79.—*Sp. Baylei*, Coq., from Algiers, (Geol. and Pal. Prov. Constant., 1862, p. 220).

80-82.—*Spondylus echinatus*, Mort., (= *Sp. capax*, Con.), *gregalis*, Mort., et *Guadaloupæ*, Rœm., (see Meek in Check-list, North Am. inv. foss., Smith. Misc. Coll., No. 177, p. 7).

83-86.—*Sp. Arrialoorensis*, *sulcatellus*, *calcaratus*, and *subcostellatus* occur in the South Indian cretaceous deposits.

PLICATULA, Lamarck, 1801, (see p. 440).

1. PLICATULA STRIATOCOSTATA, Stoliczka, Pl. XXXIV, Fig. 20.

Pl. testa ovata, apice angustata et sub-truncata, complanata, valvis sub-æqualibus, sinistra paululum majore, ad umbonem angustissime affixa, utraque breviter auriculata, superficie costulis radiantibus tenuibus, paulo undulatis, 7-8 fortioribus ad intervalla interpositis, acute tuberculatis vel spinulosis ornata.

A small species with flattened, sub-equal valves, both of which are provided with small ears, the beaks are depressed and truncate; the surface is marked with a number of thin radiating ribs, between which there are at short intervals stronger,

* Fraas notes a fragmentary specimen from Palæstine, possibly belonging to this species (Würtb. Jahreshefte, xxiii, 1867, p. 232).

† See Zittel in Denksch. Akad., Wien, xxv, pt. ii, p. 118.

‡ See Favre, Descrip. foss. Moll. de Lemberg, 1869, p. 159.

spinose ribs interposed; both are often interrupted in their course by concentric lines or furrows indicating stages of growth.

Localities.—Near Shillagoody, in a grey, conglomeratic soft sandstone; Olapaudy, in brownish, finely oolitic rock; rare.

Formation.—Arrialoore group.

2. *PLICATULA INSTABILIS*, *Stoliczka*, Pl. XXXIV, Figs. 3-14 and 19; Pl. XLVI, Fig. 3.

Pl. testa ovata, paulo obliqua, apice valde angustata, inæquivalvi, umbonibus depressis, approximatis, valva supera planata, infera plus minusve convexiuscula, nonnunquam accumulate lamellosa, ad umbonem breviter affixa; utraque radiatim costata, costis aut paucis et fortibus, aut numerosis et tenuibus, semper squamose spinulosis, spinulis depressis, angustis; dentibus cardinis in utraque valva ab apice remotis, costiformibus, in valva supera remotis, costula ligamentali medio separatis, in valva infera magis approximatis, duplicibus, partibus internis valde prominentibus, externis marginalibus, nonnunquam sub-obsoletis; impressione musculari ovato rotundata, excentrica; impressione palliali profunde impressa, continua, ab margine remote sita.

This species resembles in its ovate shape the last, but the lower valve is always somewhat convex, while the upper is flat, or very nearly so. The ornamentation is extremely variable, individually and from causes of preservation of the surface. It is almost difficult to find two specimens which would entirely agree in this respect. As a rule, young specimens have from seven to nine ribs, but the number rapidly increases by bifurcation. In very few cases, (see fig. 4, pl. xxxiv), I have observed only four ribs; immediately, however, the next stage of growth begins, the number is doubled. In well preserved younger shells the ribs are ornamented with more or less projecting, scaly spines, (see figs. 12*a* and 14 on pl. xxxiv), and only when these are partially or wholly worn off, the ribs become better discernible; they never have any distinct thinner intermediate ribs, or striae, between them. In the progress of growth, the ribs, as already stated, divide into two or more branches, and when they were originally numerous (as seen in fig. 11 on pl. xxxiv), the full grown shells offer such a densely ribbed and scaly surface as is represented in figs. 19 and 19*a* on the same plate.

The internal structure of the valves does not offer any peculiarities; in both valves the hinge-teeth are somewhat removed from the umbones, and in the upper or right valve there is a low median ridge to which the ligament was evidently attached. This ligamental ridge is also indicated in several other tertiary and recent species.

Localities.—Chokanadapooram and Ootacaud, in a white earthy limestone, very common and mostly of larger size; west and south-east of Arrialoore, in grey sandstone, common, but all specimens are of small size; other localities are Olapaudy, Comarapolliam, Shillagoody, and north of Poodoopolliam, in silicious or calcareous sandstone.

Formation.—Arrialoore group.

3. *PLICATULA MULTICOSTATA*, Forbes, Pl. XXXIV, Figs. 15, 16, 17, and 18 ;
Pl. XLVI, Figs. 5-6.

1846. *Plicatula multicostata*, Forbes, Trans., Geol. Soc., Lond., vii, p. 155, pl. xviii, fig. 3 ; *eadem* auctorum.

Pl. testa late ovata, rare sub-orbiculata, apice rotundate obtusata, margine posteriore convexo, anteriore truncato aut paululum concavo, inæquivalvi ; valvis convexiusculis, indistincte auriculatis, inferiore altera paulo majore, ad umbonem breviter adnata, rare late sessili, utraque dense radiatim costulata, costulis sub-æqualibus, in junioribus squamose spinulosis, in adultis multiply divide, plus minusve large spinulosis, in valva inferiore paululum distantioribus, interstitiis concentricis squamiforme striatis.

Shell broadly ovate, with obtuse slightly prominent beaks and indistinct ears. Some specimens are a little more oblong than others, but the form very rarely approaches to orbicular. The upper valve is a little smaller than the lower, which is generally only with a small portion of the umbo attached ; rarely is the place of attachment enlarged, and only in such case the form of the shell is subject to variation (see pl. xlvi, fig. 6). Both valves are convex, the lower slightly more so than the upper. The surface is covered with numerous, very closely set, sub-equal radiating ribs, ornamented with scaly spines. As the shell increases in size, the ribs multiply by division, and some of them often become stronger than others. The scaly spines increase in proportion, and in well preserved shells considerably project beyond the margin. The ribs are, as a rule, a little more distant on the lower than on the upper valve (compare figs. 16 and 16*b* on pl. xxxiv).

This species is very closely allied to *Pl. aspera*, Sow., from the Alpine Gosau deposits, (see Zittel in Denksch. Akad., Wien, vol. xxv, pl. ii, p. 120). There does not appear to be any essential distinction in the form and ornamentation of the shells of the two species, but in *aspera* the upper valve is always flat or even concave, while in *multicostata* the upper valve is always convex, near the beaks sometimes even considerably tumid.

The species described by d'Orbigny as *Pl. aspera* can hardly be regarded as identical with the one from the Gosau ; good materials must be compared in order to establish the relation of these two forms. We possess in our collection a specimen from Tours, in which the radiating ribs are as distant as shown in d'Orbigny's figure and the spinulose scales are of a different character. The American *Pl. urtica*, Mort., which Zittel identifies with *aspera*, is to all appearance a much more elongated shell.

Localities.—Near Serdamungalum, Alundanapooram, and Anapaudy ; common, in a yellowish brown or bluish grey sandstone.

Formation.—Trichinopoly group.

4. *PLICATULA SESSILIS*, Stoliczka, Pl. XXXIV, Fig. 21 ; Pl. XLVII, Figs. 5-7.

Pl. testa oblique ovata, inæquivalvi, valva infera convexa, ad umbonem truncata, anguste vel latiuscule affixa, parte libera radiatim costulata, costulis æqualibus, squa-

mulose sub-tuberculatis aut confertis, et æquidistantibus, aut paucioribus et sub-distantibus, omnibus simplicibus; valva supera plano-concaviuscula, ad umbonem paululum tumidula, distinctius auriculata, primo radiatim granulato striata, postea costulata, costulis iis in valva altera similibus.

The lower valve is in this species always convex, truncate, and attached at the beak with a larger or smaller area. The upper valve is variable; on the whole, it is concave, but the upper part, corresponding to the place of attachment, is either plain or slightly tumid. This portion of the valve is also differently ornamented from the rest. The radiating lines on it are thin and finely granular, while the remaining portions of both valves are covered with much stronger, scaly, and sub-tuberculated ribs, all equal in size, but either more numerous and equidistant, or in smaller numbers and, towards the periphery, more distant from each other. The form of the shell greatly resembles *Pl. spinosa*, Mant., but the ribs are comparatively always more numerous, and less spinose.

Localities.—Ootatoor, Odium, and Moraviatoor, in yellowish brown or dark brown earthy limestone; not common.

Formation.—Ootatoor group.

5. PLICATULA SEPTEMCOSTATA, Forbes, Pl. XLVIII, Fig. 4.

1846. *Plicatula septemcostata*, Forbes, Trans., Geol. Soc., Lond., vii, p. 155, pl. xviii, fig. 4—*eadem* auctorum.

P. testa sub-obliqua, sub-orbiculari, convexiuscula, inæquivalvi, longitudinaliter (= radiatim) costata, costis septem majoribus, sub-angulatis, (sub-squamosis); apice affixa, (Forbes, l. cit.).

I am unable to add anything to the knowledge of this species; there is no specimen of it in our collection. The lower valve is slightly more convex than the upper one, and both are similarly and equally strongly ribbed.

Locality.—Pondicherry.

Formation.—? Valudayoor group.

SPONDYLUS, Klein, 1753, (see p. 441).

1. SPONDYLUS ARRIALOORENSIS, Stoliczka, Pl. XXXIII, Fig. 5.

Sp. testa oblique late ovata, valva inferiore late affixa, cupuliforme, umbone moderate irregulariter producta, margine inferiore sensim elevata, radiatim costellata et concentrice crasse lamellata; valva superiore convexa, versus marginem deplanata, radiatim costellata et concentrice obsolete striata, costellis paulo inæqualibus, confertis, æquidistantibus, rugulose spinulosis, posticis paulo fortioribus quam anticis, nonnullis (3—4) crassioribus et ad intervalla spinis altis, lateraliter compressis, armatis; auriculis magnis, sub-æqualibus, sub-lævigatis, obsolete striolatis, utraque prope marginem cardinalem, fere rectum et incrassatum, costula spinulose lamellosa instructa; umbone obtuso, extra marginem paulo projiciente.

The lower valve of this species is sessile with a broad surface on a fragment of an *Inoceramus*; it is rather low at the umbo, which is irregular, and with the

front area apparently somewhat excavated; towards the margin the valve is free, obliquely elevated, radiately striated, and concentrically strongly lamellated. The upper valve is moderately convex, covered with very numerous radiating ribs, which are of sub-equal size and made sharply rugose by the concentric striæ of growth; a few of the radiating ribs are stronger, and armed with laterally compressed, tuberculous spines. The ears are rather large, almost equal, nearly smooth, with straight thickened hinge margins, near which runs a strongly foliaceous or spinulose rib; the beak is obtuse and slightly projects beyond the hinge margin; (the last two characters are not sufficiently clearly shown in the figure).

Locality.—South-west of Mullor, in soft grey sandstone.

Formation.—Arriallor group.

2. SPONDYLUS SULCATELLUS, *Stoliczka*, Pl. XXXIV, Fig. 1.

Sp. valva superiore oblique ovata, moderate convexa, irregulariter undulate rugosa, radiatim dense costellata, costellis lateraliter compressis, rugulis, sulcis profundis æquidistantibus separatis, hic et illic tuberculis crassis, squamiformibus instructis; umbone depresso; auriculis sub-æqualibus, radiatim costellatis; lunula angusta et profunda.

The irregular undulations on the surface of the upper valve seem to be, to a certain extent at least, characteristic of this species, and have probably been produced by the shell having been sessile on corals, to which fragments have been found attached. The most marked character of the species consists in the radiating, sharp, laterally compressed ribs, these being separated by deep furrows, in thickness equal to the ribs; a few strong tubercles occur on their surface, but the ribs themselves are not thickened.

Locality.—North of Poodoopolliam, in a white earthy limestone.

Formation.—Arriallor group.

3. SPONDYLUS CALCARATUS, *Forbes*, Pl. XXXIII, Figs. 6, 7, 9, and 10.

1846. *Spondylus subsquamosus et calcaratus*, Forbes, Trans., Geol. Soc., Lond., vii, pp. 154-155, pl. xviii, figs. 1-2.

Spondylus calcaratus, auctorum.

Sp. testa crassa, oblique late ovata; valva inferiore multo majore, tumida, umbone valde extensa, nonnunquam conoidea, torta, ad terminationem affixa, truncata; superficie libera radiatim costulata: costulis æqualibus, planatis, lineis impressis angustis separatis, concentrice crasse lamellosa: lamellis partim continuis, partim interruptis; area longa, sub-trigona, longitudinaliter obsolete striata et medio sulco sub-angustato instructa; valva supera plano-convexa, ad umbonem sæpe gibbosula, radiatim costulata et concentrice striata, costulis aut paucis aut numerosis, crassioribus tuberculis transverse squamiformibus ornatis; auriculis inæqualibus, postica

minore magisque obliqua, utraque ab corpore testæ jugo foliose costulato separata; area angusta, latissime trigonata, paulo declivi; cardine dentibus externis crassis et fovea ligamentali mediana, sub-quadrata, instructo.

D'Orbigny long since suggested that the two forms, described by Forbes under different names, belong to the same species. There can be little doubt on this point, however different the shells appear at first sight. In some specimens the upper valve has very few stronger ribs, in others they are numerous, there being two to five thinner ribs between each two thicker ones. The former are slightly undulating and finely rugose on account of the striæ of growth crossing them, the latter are at shorter or greater distances enlarged into broad, scale-like tubercles. In young specimens there are always only very few stronger ribs present. The ears of the upper valve are unequal, the posterior being smaller and more oblique than the anterior; each of them is separated at its base from the shell by a rugose, foliaceous ridge, of which the anterior is sometimes represented by an oblique series of transverse, elongated tubercles. This character indicates a strong relation of the Indian form to the European *Sp. truncatus*, Goldf., but in this species the stronger ribs never attain the same thickness, and the tubercles on them are much more compressed, cristate.

The lower valve varies in size: the umbonal part being more or less produced and with a larger or smaller area attached. In some specimens it is conical, with the umbonal part distinctly twisted. The radiating ribs on it are not much raised above the surface and equal, but the concentric lamellæ are strongly prominent, sharp, lamellar, some of them continuous, others partially interrupted. The internal edges of both valves are, as usually, toothed all round the margin.

Localities.—Near Coonum and near Serdamungalum, in grey sandstone.

Formation.—Trichinopoly group.

4. SPONDYLUS SUB-COSTULATUS, *Stoliczka*, Pl. XXXIII, Fig. 8; Pl. XXXIV, Fig. 2.

Sp. valva inferiore tumida, convexa, ad umbonem plus minusve late affixa, radiatim costellata et concentrice striata, striis sulcis nonnullis profundioribus inter-sectis, haud lamellosis; valva supera elongate, vel late, ovata, convexa, ad umbonem sæpe gibbosa, radiatim costulata, costulis æqualibus, haud tuberculatis, interstitiis aut æquidistantibus aut angustioribus; auriculis inæqualibus, lævigatis, auricula postica minore, angusta, margine superiore valde obliqua.

The form of the shell is somewhat variable in this species; it is either elongately or roundly ovate, sometimes irregular, evidently depending upon the surface of the object on which the lower valve was sessile. The numerous, rather fine, and equal ribs, without any larger tubercles, and the smooth unequal ears of the upper valve, readily distinguish the species from others. The furrows separating the ribs are either narrower than the ribs, or they equal them in width; but these

changes vary greatly with the state of preservation of the surface. A closely allied European species is *Spondylus globulosus*, d'Orb., only differing from the Indian form by a little more distant radiating ribs and comparatively larger ears.

Localities.—East of Parally, Moraviatoor, Odium, in yellowish compact or sandy limestone.

Formation.—Ootatoor group.

XLIV. *Family*,—*PLACUNIDÆ*.

The animal of the typical species, *Placuna placenta*,* Linné, is symmetrical; it has the mantle margins perfectly separated, surrounded with smaller and larger cirri, and internally furnished with a kind of a pendent border, as in most species of the *PECTINIDÆ*: one pair of sub-equal gills on each side, long, crescent-shaped, posteriorly attenuating to a point and united; adductor muscle moderate, sub-central, round, single; at the posterior side of it is a small, indistinct impression caused by the branchiopallial muscle, and near the hinge a third, also small, but more distinct, impression of the pedal muscle; foot sub-cylindrical, tubular, and expansible; lips large, sub-triangular; ventricle of the heart free; generative organ and rectum attached to the right mantle-lobe.

Shell equivalve, or very nearly so, compressed, thin, of a pearly tubular structure, externally becoming often finely lamellar; ligament marginal, cartilage attached to the external side of two diverging ribs in one valve, corresponding to two similar grooves or ribs in the other valve; muscular scar sub-central, round.

Gray more than 20 years ago suggested the separation of *Placuna* and its allies into a distinct family; but since the examination of the animal of *Pl. placenta* by Woodward, it has been thought better not to separate them from the *ANOMIIDÆ*. The organization of both is no doubt very similar, but we find that one of the most important characters of the *ANOMIIDÆ*, the peculiar development of the byssal muscles, is altogether wanting in the *PLACUNIDÆ*; the shells of this last family are, besides, symmetrical, equivalve, or sub-equivalve, free, supplied with a marginal ligament and internal cartilage. The habitat is also very different. *Placuna* is found on sandy shores, and has a very extensible vermiform foot, with which it can bury itself partially in the sand, spinning at the same time a few threads of byssus. *Placunema* I found loosely lying on coral-reefs. The third genus referred to this family is based upon a peculiar fossil shell from the eocene of Paris, for which Deshayes suggested the name *Hemiplicatula*. Of this last genus, an aberrant form occurs in the South Indian cretaceous deposits; it will be noticed subsequently. Of the former genera, a few fossil species have been noticed from tertiary deposits only, but none from older formations. For one or two noted from cretaceous rocks a new generic name has been proposed by Conrad, and the jurassic species have been named *Placunopsis*; both are referable to the *ANOMIIDÆ*.

* See Woodward in Ann. and Mag. Nat. Hist., 2nd ser., xvi, p. 25.

1. *Placuna*, Brug., 1792, (*Placenta*, Retzius, 1788, non Klein, 1734; eadem H. and A. Adams). Suborbicular, compressed, equivalve, anteriorly sub-auriculate, the ear being indicated by an indistinct furrow; hinge in the right valve with two unequal, moderately-diverging ribs, the posterior being the longer one; cartilage attached to the external side of the ridges in the right valve corresponding to two equally long grooves in the other valve; ligament thin, marginal; muscular scar roundish, of moderate size, sub-central, placed somewhat posterior to the median line of the hinge. Type, *P. placenta*, Linn., (*Placenta orbicularis*, Retz.,) the only recent species known. It not only differs by its slightly-diverging hinge-ribs, but also by being anteriorly indistinctly auriculate, while in *Placunema* there is no trace of an auricle.

Deshayes (Paris foss., 2nd edit., vol. ii, p. 126,) discusses at length the authorship of the name *Placuna*, and arrives at the conclusion that the name has been wrongly attributed to Solander-teste Chemnitz,* and that its true author is Bruguiér. The name has, however, been proposed for the type species *Ostrea placenta* of Linné, and should, therefore, be reserved for it, as Retzius' name *Placenta* has been pre-occupied by Klein, which fact is admitted even by Deshayes, for Klein's name was published 24 years earlier than Linné's xth edition of the Syst. Naturæ.

2. *Placunema*, Stoliczka, 1870, (*Placuna* apud H. and A. Adams). Shell irregularly sub-orbicular or sub-quadrangular, compressed, with a more or less straight hinge-margin and sub-central minute, indistinct beaks, no indication of a byssal sinus; cardinal ribs in the right valve widely diverging, sub-equal; cartilage attached to the external margins of the hinge-ribs and lodged in corresponding grooves of the other valve; muscular scars roundish, below the centre of the hinge. Type, *P. sella*, Gmel.

Only a few recent species are known. A few species have been recorded under the name *Placuna* from tertiary deposits, but the relations of the two genera have not been satisfactorily determined; one or two cretaceous forms, which had first been described as *Placunæ*, were subsequently referred to distinct genera. I have adopted a new name for this genus, because the only one, *Ephippium*, which could be used for it has been variously applied by different authors, and has besides been retained in Entomology.

3. *Hemiplicatula*, Desh., 1864, (Paris foss., 2nd edit., vol. ii, p. 128). Shell roundly oval, solid, compressed, sub-equivalve, hinge with two slightly diverging hinge-ribs in each valve, those of the right valve fitting between those of the left, which are less elevated and have between them a small fosset; the cartilage is attached, as in *Placuna*, along the external sides of the hinge-ribs, and this forms the principal distinction between the present genus and *Plicatula*, where the cartilage is situated in the median pit. Type, *Hemipl. solida*, Desh. (Olim *Placuna solida*), from the Paris basin.

The genus represents a connecting link between *Placuna* and *Plicatula*; the umbones are slightly flattened and may have been temporarily attached.

* I am unable to refer to the passage in the old edition of Chemnitz.

HEMIPLICATULA, *Desh.*, 1864, (see p. 451).

1. ? HEMIPLICATULA DETRITA, *Stoliczka*, Pl. XXXIII, Fig. 4, and Pl. XL, Fig. 7.

Hemipl. (?) testa rotundate ovata, tenui, sub-æquivalvi: valvis paulo convexiusculis, dextra alterâ magis depressa; umbonibus tumescentibus, acutis, sub-medianis; margine antico sub-umbonali leviter emarginato, postico convexiusculo et modice expanso; superficie striis concentricis crassiusculis, sub-lamellatis, et ad intervalle sulcis incrementi nonnullis notata; in utroque latere umbonis costula brevis in valvis dextra ac sinistra conspicua est: costulis sub-æqualibus.

Shell roundly ovate, rather thin; valves sub-equal, the right being a little less convex than the left one; beaks sub-central, somewhat tumid and pointed; anterior margin below the beak slightly emarginated; posterior convex and somewhat expanded; surface ornamented with concentric, rather strong striæ and some more distant undulations, indicating stages of growth. In both the valves examined the shell is only partially preserved; on the cast there is a short hinge-rib in each of them visible on either side of the beak,—these ribs meeting at the beak at an angle of about 90 degrees; the anterior rib appears to be a little longer than the posterior.

The general shape of the shell and the presence of hinge-ribs in both valves agree with *Deshayes' Hemiplicatula*, but in the present species the ribs are more diverging, and there is no distinct indication of the small pit in one of the valves of *Hemiplicatula*; as the two valves examined are, however, far from sufficiently perfect, it would be to no advantage to introduce a new generic name for them.

Locality.—Ninnyoor, in a white earthy limestone.

Formation.—Arrialoor group.

XLV. Family,—OSTREIDÆ.

The organization of the *Ostreæ* is in some respects the most simple one of all Pelecypoda. The mantle margins of the animals are quite separated, with a double thickened edge, more or less distinctly fringed; the gills are simple, the leaflets not being doubled on themselves, united posteriorly together and to the mantle; one pair of sub-triangular, elongated, labial appendages on either side of the mouth, at the base of which they are connected with a plain membrane; adductor muscle single; foot obsolete; sexes distinct.

The shells are of an elongately-ovate or of irregular shape, the former are at least temporarily free, the latter always attached with the larger valve (? the right), the left valve being usually somewhat smaller; beaks straight, irregularly bent, or spirally twisted; ligament internal or sub-internal, placed in a longitudinal groove and extending more or less at both sides of it; hinge edentulous or sometimes with an obtuse prominence below the anterior part of the ligamental area; muscular scar roundish or sub-ovate, generally excentric; pallial line entire; structure foliated externally, more or less homogeneous and sub-nacreous internally.

The *OSTREIDÆ* are principally distinguished from other allied forms of monomyarian Pelecypoda by their single gills and almost entire absence of the foot. It is, however, not certain that this latter character would apply to all the forms referable to the family, as, for instance, to many of the fossil *Gryphææ* which have no trace of attachment. And as in young oysters there is a small indication of the foot, this organ did very probably develop further in those species which remained free, while it became obsolete in others which selected a sessile habitat. Many conchologists have lately inclined to uniting all the different forms, which had been classified under the three principal genera *Ostrea*, *Gryphæa* and *Exogyra*, under the first-mentioned name. I have here retained the old suggested tri-division and also noted some of the sub-genera, because I fully believe that the three above mentioned genera are as well founded as those of most other Pelecypoda, the species grouping themselves round certain generic types. Naturally, when we become acquainted with a large number of closely allied fossils which have descended from one common stock, we find that the many intermediate forms greatly interfere with a strictly definable classificatory arrangement. And this is very much the case with fossil *OSTREIDÆ*; their remains are among the most common fossils, and their shells are often preserved in beds where, besides *PECTINIDÆ* and *AVICULIDÆ*, hardly any other kind of shells remain unaltered. The consequence is, that the generic distinctions must be framed a little wider, and based upon more general characters, than would probably be thought admissible in other families of Pelecypoda. Even those conchologists, however, who advocate the generic unity of *Ostrea* always admit the convenience of most of the divisions here adopted.

There have been very few *OSTREIDÆ* recorded from palæozoic rocks; the remains are uncertain, though it is not probable that the family is altogether absent in those old formations. In the Trias, both *Gryphæa* and *Exogyra* are certainly represented, and probably also *Ostrea*. In the Lias the species of the two first named genera are found in abundance, and those of the third become well marked. In the Dogger and Malm the number of species has considerably increased; in the cretaceous period it is again larger and attains probably its maximum. The genera are there slightly differently represented, viz., the number of species of *Gryphæa* diminishes as compared with the Jura; *Exogyra* reaches its maximum; and *Ostrea* presents the greatest variety of form, but the number of species themselves is not very large, they chiefly belong to the sub-genus *Alectryonia*. The tertiary epoch was mostly inhabited by *Ostreæ*, the two other genera are comparatively very scarce; the total number of the species of this family is most probably smaller than that in the cretaceous period alone. On the whole, there are now about 600 (more or less correctly defined) species of fossil *Ostreæ* known, while that of the recent species does not nearly amount to one-sixth of that number.

1. *Ostrea*, Linné, 1758. Shell irregular, inequivalve, attached with one valve, the other being usually smaller, more or less inequilateral, with straight or slightly curved beaks; ligament lodged in a median groove below the beaks, the ligamental area more or less extending on each side of the groove; it is marked with

fine transverse waved lines or striæ; muscular scar sub-central, varied in shape, depressed, or very little elevated; surface concentrically lamellar, or with radiating sub-obsolete ribs; type, *O. edulis*, Linn.

1a. The name *Ostrea* has been reserved for the species with foliated or concentrically lamellar shell, only occasionally there are some superficial ribs present, but they do not extend to the margin of the shell, this being entire, though sometimes irregular.

1b. *Alectryonia*, Fisch. de Waldh., 1807, (*vide* Bull. Soc., Moscou, viii, p. 108; *Lopha*, Bolten, apud H. and A. Adams; *Dendrostrea*, Swains., 1840). Shell generally attached near the beaks, irregular, usually of a broadly ovate, or rounded, more rarely of an elongated sigmoid shape; the posterior part of the hinge-line is often somewhat expanded, the muscular scar excentric and raised, the beaks slightly curved, with the ligamental groove as in *Ostrea*; surface with radiating ribs, which form strong dentations at the margin; type, *Ostrea cristagalli*, Linné. A peculiar section of *Alectryonia* are the narrow, mostly sigmoid shaped, strongly costated *Ostreæ*, represented by *O. carinata*, Lam.

Species of *Ostrea* occur in great number in the mesozoics. Those belonging to *Alectryonia* are there most numerous and decrease in the tertiaries, while the number of true *Ostreæ* increases from that time up to the present.

2. *Gryphæa*, Lam., 1801, (*Pycnodonte*, Fisch. de Waldh., 1835, Bull. Soc., Moscou, viii, p. 118; *Gryphostrea*, Conrad, 1865, Am. Journ. Conch., I, p. 15). Shell generally broadly ovate, inequivalve, usually attached when young, mostly free when adult, attached valve larger, convex, with a strongly incurved and often spirally twisted beak, smaller valve mostly flattened with a simple obtuse beak; ligamental groove simple, arched, distinct in the convex valve, flat and often represented by a uniformly striated margin only in the smaller valve; muscular scar excentric, generally somewhat impressed; type, *G. angulata*, Lam., recent.

The *Gryphææ* are first known in the Trias, and it is not improbable that they are already found in the palæozoics. In the Lias and Jura they are most numerous, in the cretaceous period their number decreases; from the tertiaries there are only few known, and in the recent state only one.

3. *Exogyra*, Say, 1819, (Am. Journ. Sc. and Arts, i and ii, p. 43). Shell usually elongately or roundly ovate, somewhat irregular or of sigmoid shape, inequivalve, right valve usually more convex, attached at the umbo, left valve depressed, or slightly elevated, beaks of both valves strongly spirally twisted; ligamental groove narrow, curved, marginal, flattened out inferiorly (or on the concave side), bounded above (or on the convex side) by a narrow deep groove, which always remains well marked, while the upper part of the ligamental groove is in old shells covered up by a shell-lamina; both valves generally have a raised fold, or a blunt tooth, at the posterior end of the ligamental groove; muscular scar excentric, impressed; type, *E. costata*, Say, from tertiary deposits of New Jersey.

The species of *Exogyra* are probably most numerous during the cretaceous period; none is known recent. There are two slightly different sections of the

genus. The one typical form has the left valve thin, quite flat, or slightly convex; the inner mantle edges are mostly smooth, the right valve usually of a roundly ovate, semi-globular or tumid form; a well known cretaceous form of this type is, for instance, *Exogyra sub-orbiculata* (= *columba*, Desh.). Sometimes the beaks of the attached valve become quite indistinct, as in *Exogyra Coulonii*, d'Orb., or in the South Indian *Ex. fausta*.

3a. The other section which may perhaps be best typified by the cretaceous *E. Boussingaultii*, d'Orb., has a sigmoid shape; the left or smaller valve is often considerably raised at the margins, flattened or sometimes even concave about the middle. To this section Fischer's name *Amphidonta* (1829) is applicable.

The *Exogyrae* are always unsymmetrical, being attached with the right valve laterally at the umbo, while the same valve of the *Gryphææ* is sometimes apparently quite symmetrical, and if there is a place of attachment it is almost or nearly central. The character of the ligamental groove in the two valves forms a good distinction between the two genera.

LIST OF CRETACEOUS SPECIES.

Coquand has very recently published a "Monographie du genre *Ostrea*," embodying all the species which have been described from authentic cretaceous rocks up to 1869. The additions and alterations of specific names will be extremely few. It would hardly appear necessary to repeat here all the names, were it not for the purpose of completing the list of all cretaceous Pelecypoda, known up to date. I shall enumerate the species according to their geological position in upper, middle, and lower cretaceous rocks, and shall at the same time arrange them according to the three generic distinctions which I have already indicated.

As regards the geographical distribution of the cretaceous *OSTREIDÆ*, Coquand gives detailed data which, with slight alterations, can be put as follows:—

						Lower-	Middle-	Upper-cretaceous.
European species (peculiar)	...	...	...	...	...	26	38	73
African	"	"	...	...	...	5	5	14
Asiatic	"	"	...	...	...	1*	6	7
American	"	"	...	...	...	4	51	?
Number of species common to Europe and Africa	...	...	...	...	...	...	...	23
Ditto ditto	"	"	Asia	...	...	...	...	17
Ditto ditto	Africa	"	"	...	...	...	...	2
Ditto ditto	Europe, Africa, and Asia	...	...	...	...	...	...	10
Ditto ditto	"	and America	...	...	...	...	...	2
Ditto ditto	Asia (India) and America	...	...	...	...	...	...	1
Ditto ditto	Europe, Africa, Asia, and America	...	...	...	...	...	...	6
Total of species occurring in the old Continent						...	...	220
Ditto ditto new ditto						...	...	53
Ditto common to both						...	...	9
								} = 273

It deserves to be noticed that the geological positions in which those species common to Europe and India occur are strikingly identical in the two countries, showing that the *OSTREIDÆ* can be considered as good characteristic fossils in tracing out the relative age of different rocks.

* The boundaries in European and Asiatic Russia are unsatisfactorily recorded.

LOWER CRETACEOUS.

Ostrea.

1-25.—*O. abrupta*, d'Orb., *Aragonensis*, Coq., *Cornuelis*, Coq., *Cottéau*, Coq., *disjuncta*, Buch, *exogyra*, Dub., (? *Gryphæa*) *exogyroides*, Rœm., *Germaini*, Coq., (?) *inoceramoides*, d'Orb., *Leymerii*, Desh., *macroptera*, Sow., *Maresi*, Coq., *Mauritanica*, Coq., *Pantagruelis*, Coq., *Pasiphaë*, Coq., *pes-elephantis*, Coq., *polyphemus*, Coq., *præcursor*, Coq., *prælonga*, Sharpe, *pustulosa*, Sharpe, *rectangularis*, Rœm.,¹ *Rouxi*, Coq., *Silenus*, Coq., (?) *Tysiphone*, Coq., *Urgonensis*, d'Orb.

Gryphæa.

26-27.—? *G. Cerberus*, Coq., *terebratuliformis*, Coq.

Exogyra.

28-44.—*E. aquila*, Goldf., *Autissiodorensis*, Cott., *Ballaquensis*,² Coq., *Boussingaulti*, d'Orb., *Callimorphe*, Coq., *Cassandra*, Coq., *Couloni*, Defr., *Eos*, Coq., *fulco*, Coq., *Loriolis*, Coq., *Minos*, Coq., (?) *neocomiensis*, d'Orb., *Palæmon*, Coq., *polygona*, Buch, *subsquamata*, d'Orb., *Tombeckiana*, d'Orb., *tuberculifera*, Koch et Dunk.

MIDDLE CRETACEOUS.

Ostrea.

45-73.—*O. Allobrogensis*, P. and Roux, *amorphæ*,* Sow., (?) *auriculata*, Defr., *bracteola*, d'Arch., *Cameleo*, Coq., *carinata*,* Lamck., *conglomerata*, Defr., *Daubnei*, Coq., *Desori*, Coq., *Dessalines*, Coq., *diluviana*,* Linné, (= *pes-leonis*, Forbes), *lignitarum*, Coq., *lingularis*, Lam., *Meslei*, Coq., *Milletiana*, d'Orb., *nummus*, Coq., *operculata*,† Reuss (haud *opercularis* apud Coquand, in tabula), *pachyrhyncha*, Coq., *pectinoides*, Defr., *pes-draconis*, Coq., *Ricordeana*, d'Orb., *Rochebruni*, Coq., (?) *Rotomagensis*, Def., *Saadensis*, Péron, *Sablieri*, Coq., *Senaci*, Coq., *Syphax*, Coq., *Tisnei*, Coq., (?) *trapezoidea*, Gein., *Vardonensis*, Coq.

Gryphæa.

74-84.—*G. Arnaudi*, Coq., *biauriculata*, Lamck., *Biskarensis*, Coq., *Cenomana*, Defr., *Delettrei*, Coq., *depressa*, Lam., *eburnea*, Coq., *Lesueuri*, d'Orb., *Poodoorensis*,* Stol., *rediviva*, Coq., *vesiculosa*,* Sow.

Exogyra.

85-107.—*E. Africana*, Lamck., *Arduennensis*, d'Orb., *Caderensis*, Coq., *canaliculata*,* Sow., *carinata*, Schloth., (= *flabellata*, Goldf., = *plicata*, Lamck., sed non *Ost. carinata*, Lam.,) *conica*, Sow., *costata*,* Say, *digitata*, Sow., *Dupuii*, Coq., (?) *Eumenides*, Coq., *fausta*,* Stol., *halioitoidea*,* Sow., *Larteti*, Coq., *Luynesi*, Lart., *Mermeti*, Coq., *Olisoponensis*, Sharpe, *Overwegi*, Buch, *quercifolium*, Coq., *Rauliniana*, d'Orb., *Rhadamantus*, Coq., *suborbiculata*,* Lam. (= *Ratisbonensis*, Schloth., = *columba*, Lam.), *Trigeri*, Coq., *vultur*, Coq.

UPPER CRETACEOUS.

Ostrea.

108-223.—*O. acanthonota*, Coq., (?) *Achates*, Defr., *acutirostris*,* Nilss., *anomiiformis*, Rœm., *appressa*, Gabb, (Pal. Calif., II, p. 203), *Arcotensis*,* Stol., *Aristidis*, Coq., *Aucapitaini*, Coq.,

¹ *O. Renevieri* is a *Hinnites*.

² Or *Bellaquensis*; the name of the locality is cited as "Bellaigues," and the name should probably better stand as *Bellaiguensis*.

* Species marked with an asterisk (*) also occur in the South Indian cretaceous deposits.

† This may be only a form of *G. vesicularis*, with the lower valve attached by a broad surface.

aurita, Reuss, *Barrandei*, Coq., *bella*, Coq., *?bellarugosa*, Shum., *biconvexa*, Eichw., *Bomilcaris*, Coq., *Boucheroni*, Coq., *Bourguignati*, Coq., *Breweri*, Gabb, *Brossardi*, Coq., *Carentonensis*, Defr., *Castellana*, Defr., *compressirostra*, Ducat., *confragosa*, Con., *(?) congesta*, Con., *conirostris*, Münst., *cortex*, Con., *crenulimarginata*, Gabb, *crenulimargo*, Rœm., *cuculus*, Coq., *cupelloides*,* Stol. *(?) curvidorsata*, Gein., *curvirostris*, Nilss., *dentata*, Defr., *denticulifera*, Con., *Deshayesi*, Fisch., *Devillei*, Coq., *dichotoma*, Bayle, *dubia*, Defr., *Eggeri*, Gumb., (Ostbayer. Grenzgeb., 1868, p. 768), *exilis*, Defr., *Forgemolli*, Coq., *Franklini*, Coq., *Gabbana*, M. and Hayd., *Garumnica* (seu *Garumnensis*), Coq., *Geinitzi*, Coq., *glabra*, M. and Hayd., *hippopodium*, Nilss., *Idriaensis*, Gabb, (Pal. Calif., II, p. 203), *intusradiata*, Gumb., *Ianus*, Coq., *Karassoubazarensis*, Coq., (= *undulata*, Eichw., non Sow.), *Lameraciana*, Coq., *licheniformis*, Coq., *limæ*, Gein., *lugubris*, Con., *Lyonii*, Shum., *Madelungi*, Zitt., *malleiformis*, Gabb, *Megæra*, d'Orb., *Merceyi*, Coq., *microsoma*, Coq., (= *minuta*, Rœm.), *multiformis*, Binkh., (*eadem* Koch et Dunker), *multilirata*, Con., *Naumanni*,† Reuss., *Nicaisei*, Coq., *Normanniana*,† d'Orb., *Numida*, Coq., *obscura*, Defr., *Oppeli*, Coq., *Oweana*, Shum., *oxyrhyncha*, Coq., *panda*, Mort., *pandæformis*, Gabb, *parva*, Defr., *patina*, M. and Hayd., *pectinata*,* L., *peculiaris*, Con., *pellucida*, Defr., *Peroni*, Coq., *Petrocoriensis*, Coq., *planovata*, Shum., *(? O.) plumosa*, Mort., *Pomeli*, Coq., *pristiphora*, Coq., *proteus*, Reuss, *quadriplicata*, Shum., *Rabelaisi*, Coq., *Reboudi*, Coq., *Renoui*, Coq., *Ritteri*, Dubois, *robusta*, Con., *Rouvillei*, Coq., *Scaniensis*, Coq., *Schafhæutli*, Coq., *sempi plana*, Sow., *serrata*, Defr., *squama*, Lam., *(? O.) striatula*, Eichw., *subovata*, Shum., *subspatulata*, Sow., *subtrigonalis*, E. and Shum., *tecticosta*, Gabb, *Telugensis*,* Stol., *tetragona*, Bayle, *translucida*, Meek and Hayd., *triangularis*, Schloth., *trigoniiformis*, Coq., *trinacria*, Coq., *Tuomeyi*, Con., *ungulata*,* Schloth., (= *tegulanea*, Forbes, = *Ponticeriana*, d'Orb., = *larva*, Goldf.), *variabilis*, Defr., *ventilabrum*, Dubois, (non Goldf.), *(? = semiplana*, Sow.), *Verneuli*, Leym., *Villei*, Coq., *villicata*, Con., *(? = acutirostris*, Nilss.), *Wegmanniana*, d'Orb., *Zitteliana*,* Stol.

224-228.—*Ostracites aquilinus*, *crista-parasiticus*, *crista-vaginatus*, *mactroides* and *subchamatus*, of Schlotheim, are, besides several others by DeFrance, Dubois, and others previously mentioned, almost only known by name. They can only be identified by the examination of the original specimens.

I may also mention the following species described and figured by Schafhæutl (Süd-Bayern's Leth. Geog., 1863, p. 135 et seq.): *Ostrea sella*, *cineta*, *decurtata*, *prærupta*, *semipectinata*, *caudata*, *suborbiculata*, *abscissa*, *orbis*, *unguiculus*, *mammilla*, *folium* and *falcata*; all are honored with the author's "*miki*," though several of the names had been previously applied to other species. Which of these are cretaceous and which from other formations, it is impossible to say at present; some are noted as "*Kreidepetrefact*."

Gryphæa.

229-246.—*G. Ariana*,* Stol., *Arrialoorensis*,* Stol., *(? G.) belliplicata*, Shum., *Costei*, Coq., *cretacea*, Mort., *(? G.) cyrtoma*, Alth., *fornix*, Eich., *gibba*, Reuss, *lateralis*, Nilss., *mucronata*,‡ Gabb, *navia*,§ Con., *Pitcheri*, Mort., *proboscidea*,|| d'Archiac, *Reussii*, Gumbel (Ostbayer. Grenzgeb., 1868, p. 769), *thirsæ*, Gabb, *uncinella*, Leym., *vesicularis*,* Lam., *vomer*, Mort.

Exogyra.

247-273.—*E. arietina*, Rœm., *Bourgeoisii*, Coq., *Bradakensis*, Coq., (= *contorta*, Eichw.), *Coniacensis*, Coq., *decussata*, Goldf., *Ferdinandi*, Coq., (= *læviuscula*, Rœm., non Münst.), *Fourneti*, Coq., *fragosa*, Coq., *Heberti*, Coq., *inflatata*, Goldf., (= *Ost. subinflata*, d'Orb., non *Ost. inflata*, Gmel., aut Desh.), *laciniata*,* Nilss., *Langloisi*, Coq., *Matheronana*, d'Orb., *minima*, Desh., (non

* Species marked with an asterisk (*) also occur in the South Indian cretaceous deposits.

† Possibly belonging to *Hemiplicatula*, or some other allied genus.

‡ Gabb, Pal. Calif., II, p. 274.

§ Ibidem, p. 273.

|| To this species very probably belongs also *G. bulla*, Schafhæutl (Süd-Bayern's Leth. Geog., 1863, p. 144).

Menard), *Münsteri*, Hag., *ostracina*,* Lam., (= *haliotoidea*, Schloth., = *cornu-arietis*, Nilss., = *stomatoidea*, Forbes), *plicifera*, Duj., *Puschii*,† Coq., *reticulata*, Gein., *sigmoidea*, Reuss, *Sollieri*, Coq., *squamula*, Reuss, *striato-costata*, Eichw., *Tamulica*,* Stol., *Texana*,‡ Rœm., *Trautscholdi*, Coq., (= *contorta*, Eichw. ex parte), *Washingtoni*, Coq., (= *parasitica*,§ Gabb).

EXOGYRA, Say, 1821, (see p. 454).

1. EXOGYRA HALIOTOIDEA, Sowerby, Pl. XXXVI, Fig. 7, and Pl. XXXVII, Figs. 1-3.

1813. *Chama haliotoidea*, Sow., Min. Conch., i, p. 67, pl. 25.—*Gryphæa*, *Exogyra*, aut *Ostrea eadem* auctorum.

1846. *Exogyra orientalis*, Forbes, Trans. Geol. Soc., Lond., vii, p. 156, pl. xiv, fig. 6.

1869. *Ostrea lucifer*, Coquand, Monog. Ostr. cret., p. 43.

Ex. testa late semiovata, auriforme, depressa, sub-lævigata, ad marginem dorsalem convexa, ad ventralem rectiuscula; valva affixa planulata, nonnunquam irregulariter excavata, ad marginem convexum subcarinata, deinde rapide declivi, umbone valde intorto, valva libera fere plana, ad marginem convexum aliquantum incrassata, umbone indistincto; fovea ligamentali longa, marginali, infra costa elevate marginata; impressione musculari subcentrali, magna, elongate ovata.

Forbes already noticed the great similarity of his *E. orientalis* to the European *E. haliotoidea*, pointing out that the difference consists in the angle of the larger valve being more marginal, while in the European it is more median. This character is, however, not constant, either in the European or in the Indian form. I can see no essential difference between most of our specimens and those originally figured by Sowerby (loc. cit.). The form of both the valves is almost exactly the same, even applying to some peculiar rugosities along the ventral margin. Specimens in which the angle of the larger valve is more median (see pl. xxxvii, fig. 2,) also occur in South India, but they are rare, while in Europe the same are of more common occurrence. Sometimes the form of the shell is nearly roundly ovate, or the larger valve is almost gibbose and rough on the surface.

D'Orbigny (Prod. ii, p. 256,) considered the present species, or rather Forbes' *E. orientalis*, as identical with his *E. stomatoidea* = *E. ostracina*, which identification is of course inadmissible. Coquand's newly proposed specific name *lucifer* also becomes obsolete.

Locality.—Ootatoor, in a grey or reddish calcareous sandstone.

Formation.—Ootatoor group.

E. haliotoidea has been found in the Upper Greensand of England, at various localities in France, Germany, Bohemia, Sweden, &c.; it is a characteristic fossil of the middle series of cretaceous deposits, (*Rotomagien* of Coquand), and holds exactly the same position in South India, where it occurs in the lowest beds of our series with *Amm. Rotomagensis*, *rostratus*, and many other characteristic species.

* Species marked with an asterisk (*) also occur in the South Indian cretaceous deposits.

† Very closely allied to *haliotoidea*, Sow.

‡ Gabb (Pal. Calif., II, p. 275,) identifies this species with *Exogyra carinata* (= *plicata*, Lam. = *flabellata*, Goldf.).

§ I do not think this change of name will be necessary, because the species belongs to a genus different from that to which it was referred by Coquand.

2. EXOXYRA OSTRACINA, *Lamarck*, Pl. XXXV, Figs. 6—12, and Pl. XXXVI, Figs. 1—4.

1801. *Planospirites ostracina*, Lamk., An. s. vert., p. 700.
 1820. *Ostracites haliotoideus*, Schlotheim, Petrefactenk., p. 28 (non Sow.).
 1821. „ *auricularis*, Wahlenberg, Petref., p. 58, (non Brong., 1822).
 1846. *Exogyra stomatoidea*,* Forbes, Trans. Geol. Soc., Lond., vii, p. 156.
 1847. *Ostrea crepidula*, d'Orbigny, Voy. d'Astrolabe, Paléont., pl. v, figs. 43-44 (non Desh.).
 1850. „ *subinflata*, d'Orbigny, Prod., ii, p. 256, *ex parte*.
 1869. „ *auricularis*, Geinitz et *O. cornu-arietis*, Coquand, Mon. Ostr. cret., p. 28, pl. viii, figs. 1—12.

Ex. testa elongato ovata; valva majore, aut inferiore, plus minusve elevata, nonnunquam planulata, prope marginem superiorem angulata, umbone valde incurvo et spiraliter torto, striis et plicis incrementi concentricis et in declivitate supera, plus minusve præcipitata, nonnunquam costis nonnullis obliquis notata, prope umbonem sessili; valva minore, (aut supera,) rare planata, sæpissime ad marginem convexum elevata, in declivitate concentrice rugose striata et decussatim striolata, medio plana aut concava, tenui, umbone valde intorta; sulco ligamentali angusto, marginali, curvato, in valva majore costa elevata, in minore dente elongato, obtuso, infra marginato; impressione musculari latiuscula, irregulariter subquadrata, excentrica, impressa, modo infra umbonem oriente; margine palliali undique minute crenulato et striolato.

This is an extremely variable species, but always possessing a more or less ovate shape, with strongly spirally twisted beaks, usually attached by a portion of the larger, or lower, valve. This latter is on the surface flattened, near the convex margin angulated, and from there more or less rapidly sloping towards the margin itself. Young, or smaller, shells have this slope generally narrow, covered with the usual concentric striæ and plications of growth, or there are only a few oblique indistinct ribs traceable on the slope (see pl. xxxv, fig. 10), or the ribs are all of considerable strength, as seen in fig. 8, pl. xxxv, and fig. 2, pl. xxxvi. The gradations from one form to the other, collected at the same locality, are so gradual that no specific importance can be attached to them. The plications are, however, very different from those of *Ex. plicifera*, Duj., (*Ostrea eadem* apud Coquand). In this species the ribs do not begin at the angle and extend over the entire slope, but they originate below it, and are also much more numerous.

Again, in larger shells the upper, or dorsal, slope often somewhat expands posteriorly, and is then less precipitous (see pl. xxxvi, fig. 4). The strength and regularity of all the striæ and folds of growth greatly depend upon the regularity of the object on which the species is sessile. This, partially at least, also applies to the strength of the ribs on the upper slope; for these ribs are, as a rule, only found developed in such specimens as possess an irregular place of attachment. When the upper somewhat perlaceous layer of the shell is decomposed, the inner layers exhibit a fine radiating striation, apparently produced by the tubular structure of the shell (see pl. xxxvi, figs. 4a & 4b).

The smaller or upper valve is rarely flat, more generally concave, along the convex margin considerably raised and marked with concentric, close plications and

* *Errore-typico staumaloidea* apud d'Orbigny, Prod. ii, p. 256, et *staumatoidea* apud Coquand.

numerous decussating striæ; the beak is always equally strongly incurved as in the other valve. In both the pallial margin is finely crenulated all round, and at the ventral side, where near the hinge, it is reflected over a portion of the ligamental furrow and the beaks, is finely striolated. The muscular scars are irregularly excentric, being situated somewhat near the ventral margin, excavated, and their upper edge begins almost immediately below the region of the beaks.

The Indian specimens, in which the ribs are not present on the dorsal slope of the larger valve, perfectly agree in general character with European ones, particularly with those from the Pyrenees mountains, described by Leymerie as *Exogyra pyrenaica*. Even in specimens of this form, for which we are indebted to Prof. Hebert, I can, however, observe an indication of slight folds or ribs on the larger valve, and this seems to make it doubtful whether Coquand is correct in all the references quoted as synonyms of the three closely allied species, *Ex. ostracina*, (= *auricularis*), *E. Matheronana* et *E. plicifera*.

Localities.—Vylapaudy, south-east of Kaudoor, east of Nullaenaccary, Arrialoore, Valore, &c., &c., mostly in a softish grey sandstone, at the last named locality in a white calcareous rock.

Formation.—Arrialoore group.

In Europe *Ex. ostracina* has been found at a great number of localities, in France, Germany, Sweden, Austria, Russia, &c., in upper cretaceous beds (étage Campanien of Coquand); in similar strata the species has also been met with in North and South America, in North Africa, and in Syria and Palæstine; in India it is also a characteristic fossil of the uppermost beds of the series of the Trichinopoly deposits, the Arrialoore group.

3. EXOGYRA LACINIATA, Nilsson, Pl. XXXVIII, Figs. 1—3.

1827. *Chama laciniata*, Nilss., Petref. Suec., pl. viii, fig. 2.

1869. *Ostrea laciniata*, apud Coquand, Mon. Ostr. cret., p. 55.

Ex. testa irregulariter elongato ovata, valva majore valde convexa, medio longitudinaliter gibboso carinata, lateraliter prope umbonem sessili, in declivitate convexa radiatim sparse crasse-costata, costis irregularibus, curvatis, lamellose nodosis, ad marginem plus minusve projicientibus; umbone valde intorto, nonnunquam indistincto; valva minore planata aut modice concava.

Of this interesting species only a single specimen exists in our collection from South India. The species is readily recognised by the ovate, inflated form of the larger valve and by the few strong ribs which are very prominent on its upper or convex slope, while on the ventral side the shell is generally more irregular, being attached near the beak. Coquand already quotes this species from Verdachellum.

Locality.—Ninnyoor, in a light brown sandy limestone.

Formation.—Arrialoore group.

In Europe *Ex. laciniata* has been found in the upper cretaceous beds (Campanien of Coquand) of various parts of England, France, Germany, and Sweden.

4. EXOGYRA FAUSTA, *Stoliczka*, Pl. XXXVIII, Figs. 4—5; Pl. XXXIX, Figs. 3—5.

Ex. testa irregulariter ovato elongata aut sub-quadrata; valva inferiore aut prope umbonem, aut magna parte lateris ventralis, sessili, gibboso convexa, prope medium maxime elevata, radiatim costata: costis sparsis, sæpe dichotomis, lamellis concentricis irregularibus interruptis, aut acute rugatis; umbone modice prominulo, valde intorto, apice depressiusculo, indistincto; fovea ligamentali longa, angusta, sub-marginali, curvata, ad apicem sulcum elongatum, dentem valv. alteræ recipientem, carente; impress. musc. late ovulata, antice (vel supra) truncata, haud procul ab umbone sita; marg. pall. pone terminationem foveæ ligam. breviter crenulato; valv. superiore undulate planata, concentrice sub-rugosa et ad marginem convexum paulo incrassata et undulate lamellosa.

The form of the shell of this species is very variable, the larger valve being either only with a small portion of the beak sessile or with nearly the whole of the lower half. According to the amount, or place, of attachment the gibbosity of the larger valve is more or less regular. The surface is marked with comparatively few, irregular, often divided ribs, which are intersected by strong concentric lamellæ of growth, mostly prominent on the ribs. Near the margin the ribs become obsolete or very nearly so. The smaller valve is usually somewhat undulating, smooth or covered with a few concentric rugosities, and at the convex margin it is always more thickened and lamellated. The only species which can be compared in general character with the Indian fossil is *Exog. Olisoponensis*, Sharpe, from Portugal (Coquand, Mon. Ostr. cret., p. 125), but in this species the ribs are still less in number on the larger valve, and its beak is much more prominent and more strongly spirally incurved.

Locality.—Anapaudy, in a brownish sandstone.

Formation.—Trichinopoly group.

5. EXOGYRA COSTATA, *Say*, Pl. XL, Figs. 1—3; Pl. XLI, Fig. 1.

1821. *Exogyra costata*, Say, Am. Journ. Sc. and Arts, ii, p. 53.

1834. *E. costata* et ?*Ostrea torosa*, Morton, Synop., pp. 50 and 55, pl. vi, figs. 1-4, and pl. x, fig. 1.

1869. *Ostrea torosa*, apud Coquand, Mon. Ostr. cret., p. 38.

Ex. testa rotundate ovata; valva majore inflata, umbone valde intorto, lateraliter sessili, concentrice lamellate striata et radiatim costulis irregularibus, confertis, partim undulatis, sæpe interruptis et dichotomis, ornata; valva minore plana, concentrice striata, nonnunquam costulis nonnullis radiantibus tecta; impressione musculari prope umbones sita, excavata, transversaliter sub-ovata; fovea ligamentali longa, profunda, angusta, marginali, lente curvata, infra acute marginata et area rugulosa sub-triangulari sub-posita.

I can see no difference between specimens from South India and those from North America; smaller and larger specimens perfectly agree in form, in the

numerous closely set ribs, being often interrupted by concentric lamellæ of growth, in the narrow ligamental furrow, and in the transversally subovate and deep muscular scars.

Locality.—East of Poodoor, in a light brown calcareous sandstone.

Formation.—Ootatoor group.

E. costata has been found at a great many localities in the cretaceous beds of North America. Coquand transfers it to the "Campanien," but does not state the reason for this stratigraphical determination. The only European species allied to *E. costata* is *E. Overwegi*, Buch; it is a less oblique and more elongated shell.

6. EXOGYRA TAMULICA, *Stoliczka*, Pl. XLI, Figs. 2—3; Pl. XLII, Fig. 1.

Exog. testa elongato ovata; valva majore, convexa, inflata, prope umbonem sessili, concentric confertim costulata, costulis undulatis, rugulosis, subnodulosis et subundulatis, nonnunquam in parte sub-umbonale striis lamelliformibus confertissimis substitutis; umbone valde intorto; fovea ligamentali longa, marginali, curvata, profunda, angusta, postice latiuscula, infra costa acuta marginata, et infra eam dente transverso, obtuse elongato, instructa; impressione musculari lata, sub-rotundata, supra, (vel antice), truncata, sub-centrali; impress. pallial. dorsaliter, (seu ad marginem convexum), minute crenulata; (valvam minorem non vidi).

A species closely allied to *Ex. Fourneti*, Coq., (Mon. Ostr. cret., p. 26), but it is more regularly ovate, apparently with the beaks less distinctly incurved, and with the concentric rugulose ribs more distinct. The hinge is decidedly different, there being in the specimens a strongly curved marginal ligamental groove, widening posteriorly, and near the anterior part is a transverse blunt tooth enclosing between it and the beginning of the ligamental furrow a small pit in which evidently a tooth of the other valve fits, quite similar to that in *Ex. ostracina*; the muscular scar is subcentric, a little nearer to the beak than to the posterior margin; it is roundish, with a truncate edge anteriorly, or above. In *E. Fourneti* the hinge-tooth is represented by a long rib, and the muscular scar is placed more posteriorly, or inferiorly. The upper valve has not been observed.

Locality.—Near Arrialoore, in a pinkish calcareous rock.

Formation.—Arrialoore group.

7. EXOGYRA SUBORBICULATA, *Lamarck*, Pl. XXXV, Figs. 1—4.

1802. *Gryphæa suborbiculata*, Lamck., Systeme des An. sans. vert., p. 398.

1813. *Gryphites Ratisbonensis*, Schloth., Tasch., vii, p. 105.

1819. *Gryphæa Columba*, Lamck., An. s. vert., vi, p. 198.

1869. *Ostrea Ratisbonensis*, Coquand, Mon. Ostr. cret., p. 121, cum syn.

Ex. testa irregulariter sub-orbiculata, valva majore inflata, lævigata, interdumque irregulariter rugulose striata, in declivitate antica sulco lævi haud procul ab umbone ad marginem decurrente notata, umbone valde prominente, attenuato et spiraliter

incurvo, nonnunquam irregulari, sessili; valva minore aut plana aut paulo concava, sub-lævigata, in parte postica et ad marginem undique striis lamellatis concentricis instructa; fovea ligament. longa, curvata, angustissima, profunda; impressione musc. excentrica, sub-antica, late rotundateque ovata.

The specimens from South India perfectly agree with the European species, so well known under the name *Ex. columba*. Irregularities in the lower valves, depending upon the form of the object to which they are found attached, are found in India and in Europe. A peculiar form is represented in fig. 4, pl. xxxv, in which the shell near the beak is irregularly striated, or rather ribbed, the ribs extending posteriorly almost to the margin. Other forms found in the same locality are quite smooth and barely show a trace of attachment. The species attained in India the same large size as in Europe.

It seems almost a pity to abandon the well known name *Ex. columba*, but if strict priority has to be enforced, Lamarck's oldest name *suborbiculata* must be adopted, and not *Ratisbonensis* of Schlotheim, for Lamarck had no more right to give up the former name, than other authors had a right to prefer *Ratisbonensis* to *columba*.

Localities.—Poodoor, Monglepaudy, north-east of Puravoy, in brownish calcareous sandstone.

Formation.—Ootatoor group.

This species is characteristic for the Upper Greensand, or the middle series of cretaceous deposits (Carentonien of Coquand); it holds exactly the same horizon in India. It has been found all through Europe and Northern Asia.

8. EXOZYRA CANALICULATA, Sowerby, Pl. XLVIII, Figs. 6—8.

1813. *Chama canaliculata*, Sow., Min. Conch., I, p. 68, pl. 26, fig. 1.

1869. *Ostrea canaliculata*, apud Coquand, Mon. Ostr. cret., p. 128, cum syn.

Ex. testa irregulariter sub-ovata; valva majore convexa, prope umbonem lateraliter sessili et plus minusve irregulariter expansiuscula, lævigata, lamellis incrementi nonnullis distantibus notata; umbone angusto, depressiusculo, lateraliter intorto; valva minore aut planata, aut concava, ad umbonem plus minusve distincter tortum paulo elevata, concentricè crasse lamellata, nonnunquam striis radiantibus, interruptis, indistinctis, sparsim notata, margine ventrali et dorsali prope umbonem denticulato.

This species is, as pointed out by Coquand, very closely allied to *Ex. lateralis* of Nilsson, the latter having apparently the larger valve longitudinally more narrowly convex and the smaller valve less strongly lamellated. In these points the few Indian specimens of the larger valve better agree with *canaliculata*, and so does also the ornamentation of the smaller valve, possessing on the surface a few radiating lines, which are also indicated in Sowerby's original figure. The Indian

specimens most closely resemble some of the figures given by Reuss in his Böhm. Kreidef., pl. 27. Reuss refers these specimens from the Pläner-limestone to Nilsson's *E. lateralis*, and is followed in this by Coquand, but it seems more probable that they belong to the present species.

Localities.—North by east of Odium, in a silicious sandstone (smaller valve), west by south of Illpagoody (in a brown finely oolitic soft rock (three larger valves).

Formation.—Ootatoor group.

In Europe *E. canaliculata* characterizes the middle series of cretaceous deposits. It was found in the greensand of England, in the Carentonien and Rotomagien of France, and in similar beds of Belgium and Germany.

GRYPHÆA, Lamarck, 1801, (see p. 454).

1. GRYPHÆA POODOORENSIS, Stoliczka, Pl. XXXV, Fig. 5.

Gryph. testa regulariter ovato elongata, valva majore moderate tumida, fere æquilaterali, umbone valde incurvata, intorta, costulis radiantibus (circiter 16), interspatiis multo latioribus separatis, et striis incrementi tenuibus, ornata.

Only the figured specimen has been examined of this interesting species; its larger valve is nearly quite regularly ovately elongated, moderately convex, gradually sloping posteriorly, with the beak strongly incurved, but barely twisted; the surface is ornamented with rather thin, radiating ribs separated by much broader interspaces. Striæ of growth very fine. The smaller valve has not been seen.

Locality.—Near Poodoor, in a pinkish limestone.

Formation.—Ootatoor group.

The only cretaceous species which bears some resemblance to the Indian fossil is *Ostrea Cerberus* of Coquand (Monog. Ostr. cret., p. 166, pl. lxvi, figs. 3—4), but the ribs in that species are much stronger and fewer in number.

2. GRYPHÆA ARRIALOORENSIS, Stoliczka, Pl. XLV, Figs. 13—14, and Pl. XL, Fig. 9.

Gryph. testa linguiformi curvata, apice sub-obtusa, postice rotundata; valva inferiore (dextra) convexiuscula, prope umbonem sæpissime sessili, umbone aut indistincto aut breviter intorto; valva altera vix minore, planulata, vertice nonnunquam mammillato: ambabus sub-lævigatis, striis incrementi sub-lamellatis tectis, marginibus internis prope umbones minute crenulatis.

A small linguiform and smooth species, with the lower valve moderately convex and usually attached near the umbo, which is small, either indistinct, or laterally incurved. The upper valve is only a little smaller than the lower, and sometimes with a mammillate apex, but not twisted.

The species greatly resembles the European *O. Scaniensis*, Coq., (Mon. Ostr. cret., 1869, p. 44, pl. 17, figs. 14—16), but is comparatively shorter and has not a trace of radiating ribs on the convex valve. Should, however, the presence of those ribs not prove to be an essential character in *Scaniensis*, there would hardly remain sufficient grounds for separating both. Another allied species is *O. rediviva*, Coq., (loc. cit., p. 154), which only differs from the Indian form by its much narrower and more elongated shape.

Localities.—East and west of Arrialoore, in whitish sandstone and in a brownish conglomerate.

Formation.—Arrialoore group.

3. *GRYPHÆA ARIANA*, *Stoliczka*, Pl. XLIII, Fig. 2; Pl. XLIV, Figs. 1—3.

Gryph. testa elongata, sub-linguiformi, curvata, crassissima, concentrice lamellose striata; valva maj. convexa, lateraliter ad umbonem sessili, umbone breviter incurvo, fovea ligamentali lata, modice excavata, ad apicem valde angustata et curvata, impressione musculari late ovata, fere centrali; valva superiore sæpissime paulo concava, apice obtusa aut truncata, area ligamentali latissima, sub-plana; margine interno lævi.

Shell very solid, elongated, somewhat curved and usually sessile at the beak of the convex valve; both valves are only marked with strong lamellæ of growth; the muscular impressions are nearly central, ovate; the ligamental area excavated in the convex, flattened in the other valve, and in both very large. From the small *G. Arrialoorensis* the present species is easily distinguished by its more gibbous form and the more obtuse beaks.

Locality.—Comarapolliam, in conglomeratic sandstone.

Formation.—Arrialoore group.

4. *GRYPHÆA VESICULARIS*, *Lamarck*, Pl. XLII, Figs. 2—4; Pl. XLIII, Fig. 1; Pl. XLV, Figs. 7—12.

1806. *Ostrea vesicularis*, Lam., Ann. Mus., viii, pl. 22, fig. 3.

1869. „ „ Coquand, Mon. Ostr. cret., p. 35, cum synonym.

Gryph. testa irregulariter sub-rotundata aut elongato ovata, valva inferiore crassa, gibbosa, sub-lævigata, concentrice lamellose striata, interdumque radiatim sparse sub-costata, libera aut sessili, lateraliter ad marginem (inferiorem) lobata, lobo postice nonnunquam sinu distincto separato; umbone obtuse attenuato, modice incurvo, haud torto, nonnunquam indistincto et breviter adnato; area ligamentali magna, late sub-trigona, medio excavata; impressione musc. sub-centrali, paulo inferius posita, excavata, late sub-rotundata; valva superiore aut plana aut paulo concava, altera multo minore et tenuiore, lævi, lineis radiantibus nonnullis interdum notata; margine pall. in utraque valva prope umbones rugulose plicatulo.

This well known upper cretaceous species is found abundant in the Arrialoore group of South India. Young specimens often show on the flat valve some

fine radiating lines, but there are very rarely any ribs to be observed on the larger valve. From its close ally, *Gryph. proboscidea*, d'Arch., the present species is distinguished by the greater development of the ligamental area and the marginal lobe, while in *proboscidea* the furrow, separating the last, is more median. The globosity, or gibbous form, of the larger valve is, however, not a reliable character for distinguishing the two forms, and young specimens of both are often very difficult to separate.

Localities.—Comarapolliam, Arrialoor, Ninnyoor, in whitish sandstone.

Formation.—Arrialoor group.

G. vesicularis is a characteristic fossil of the upper cretaceous beds (Campanien of Coquand); it has been found almost throughout Europe in these beds, as well as in North America, Algiers, Syria, and Asiatic Russia.

5. GRYPHÆA VESICULOSA, Sowerby, Pl. XXXIX, Figs. 1—2.

1823. *Gryphæa vesiculosa*, Sow., Min. Conch., vi, pl. 369.

1869. *Ostrea vesiculosa*, apud Coquand, Monog. Ostr. cret., p. 152.

Gryph. testa aut oblonga aut irregulariter sub-rotundata; valva inferiore tumida, valde convexa, sub-lævigata, striis incrementi tenuissimis tecta, libera aut prope umbonem sessili, indistincte lobata interdumque parte infero-posteriore sensim producta, umbone sub-acuto, incurvo vel truncato; area ligamentali lata, medio modice excavata; impress. musc. sub-ovata, excentrica, postero-inferiori, paulo profunda; impress. pall. ad umbonem impressa, indistincte plicatula, (valvam minorem, lævigatam, concaviusculam non vidi).

This species differs from the previous by its smaller size, thinner shell, more tumid and very indistinctly or not at all lobed larger valve, and the almost smooth pallial impression, &c. It is also a geologically older form.

Localities.—East of Poodoor and north-east of Odium, in a whitish friable calcareous rock; only one specimen was found at each of the localities.

Formation.—Ootatoor group.

G. vesiculosa characterizes the middle cretaceous beds, the Rotomagien of Coquand. It was found in these beds (Upper Greensand) in England, in France, Belgium, Germany, Bohemia, Switzerland, and in Syria. In India it also occurs with *Amm. Rotomagensis*, *Inoceramus mytiloides*, *Exogyra canaliculata*, &c.

OSTREA, Linné, 1758, (see p. 453).

1. OSTREA [ALECTRYONIA] DILUVIANA, Linné, Pl. XLVI, Figs. 1—2; Pl. XLVII, Figs. 1—2.

1767. *Ostrea diluviana*, Linné, Syst. nat., p. 1148.

1846. *Ostrea pes-leonis*, Forbes, Trans. Geol. Soc., Lond., vii, p. 156, pl. 18, fig. 5.

1869. *Ostrea diluviana*, apud Coquand, Mon. Ostr. cret., p. 120, cum. syn.

Ost. [Alectr.] testa irregulariter ovata aut sub-tetragona, sub-æquivalvi; valva inferiore paulo majore, plus minusve latiuscule affixa, utraque radiatim costata:

costis acutis, simplicibus aut dichotomis, interspatiis fere æqualibus separatis, concentricè minute striolatis, in latere dorsali sæpissime fortioribus, ad marginem crasse dentatis, dentibus in margine ventrali nonnunquam sub-obsoletis vel minoribus; area ligamentali late triangulata, medio leviter impressa; valva supera ad apicem sæpe abbreviata aut truncata; impress. musc. late ovata, excentrica, ventrali, sub-marginali; impress. palliali lævi, sæpe indistincta.

The great variations in form of this species are well known, though generally a more or less ovate shape is traceable. The valves are sometimes almost equal, but usually the upper one is somewhat less elevated, the ventral margin is in both near the beak usually somewhat expanded. The development of the ribs depends upon the amount of attachment of the lower valve, and where the ribs are wanting on this one they are equally so on the other valve. On the free portions of the valves the ribs are, however, always well marked, sharp, about equidistant, single or dichotom, and very often nearly of equal strength; only occasionally one or two of the median ribs become much stronger than the others. The margins are dentated according to the size of the ribs; on the ventral side the dentation is generally less strong than on the dorsal one. The ligamental area is large, sub-triangular; the beak is in the lower valve generally entire, sometimes slightly curved; in the upper the cardinal edge is generally truncate, and the ligamental area, therefore, shorter, and in the middle also less excavated.

I can see no essential difference between Indian specimens and those from various parts of Europe. Coquand (Monog. Ostr. cret., p. 87,) identified Forbes' *O. pes-leonis* with *O. Deshayesi*, Fischer, but this last species differs apparently by having the ribs less sharp and the muscular impression more removed from the umbones.

Localities.—Anapaudy and Serdamungalum (in brownish calcareous sandstone, Trichinopoly group), Moraviatoor, Odium, Ootatoor, (in earthy limestone, Ootatoor group).

Formations.—Trichinopoly and Ootatoor groups.

In Europe this species occurs in the middle cretaceous series (*Carentonien* and *Rotomagen*); it is one of the most common species all through Germany and France, and is also reported by Eichwald from Daghestan.

2. OSTREA [ALECTRYONIA] CUPELLOIDES, *Stoliczka*, Pl. XLVI, Fig. 4.

Ost. [Alectr.] valva inferiore cupelliforme, sub-rotundata, tenui, ad umbonem late affixa, radiatim costata, costis modice elevatis, æquidistantibus, striis incrementi tenuissimis ac confertissimis tectis, ad marginem undique obsoletis; area ligamentali medio latiuscula et modice excavata; impress. musculari ventrali, excentrica, indistincta; imp. palliali plicosa, sub-marginali.

Locality.—Near Arrialoor, in whitish sandstone.

Formation.—Arrialoor group.

I have not seen more than the figured lower valve of this remarkable species. The radiating ribs all become obsolete near the margin and the pallial impression is crenulated in its entire extent, which character readily distinguishes this species from any others reported from cretaceous deposits.

3. OSTREA [ALECTRYONIA] AMORPHA, *Sowerby*, Pl. XLVIII, Fig. 3.

1846. *Ostrea amorpha*, Sow., apud Forbes, Trans. Geol. Soc., Lond., vii, p. 157, pl. 15, fig. 24—*eadem* auctorum.

Ostr. [*Alectr.*] *testa irregulariter sub-rotundata, convexiuscula, crassa, radiatim inæqualiter costata: costis ad marginem plicis nonnullis concentricis intersectis.*

I have unfortunately very little to add to the meagre description of this problematic species. The only specimen in our collection is very imperfect, but it indicates a species allied to *O. Desori*, Coq., (Monog. Ostr. cret., 1869, p. 117), and may be identical with it. The geological position of both also corresponds, *Desori* being from the Carentonien. Forbes' figure is based upon a very insufficient fragment, exhibiting the interior of it; it is the only one that I could find amongst Forbes' originals.

Locality.—Near Serdamungalum, in bluish grey sandstone.

Formation.—Trichinopoly group.

4. OSTREA [ALECTRYONIA] CARINATA, *Lamarck*, Pl. XLVIII, Fig. 5; Pl. XLIX, Figs. 1—2.

1810. *Ostrea carinata*, Lam., Ann. d. Museum, viii, p. 166;—*eadem* Coquand, Monog. Ostr. cret., 1869, p. 129, cum synon.

O. [*Alectr.*] *testa elongata, angusta, curvata, æquivalvi; valvis costis numerosis ad medium complicatis, et irregulariter dichotomis, sub-rugosis, in latere antico, concavo, simplicibus, in latere convexo abrupte descendentibus, supra ad marginem elevatiusculis, nonnunquam duabus vel tribus seriebus tuberculorum coronatis ornatis; auriculis parvis, aut sub-æqualibus, aut sub-obsolete; umbonibus sæpissime paulo incurvatis; ligamentum in fovea ampla valvulæ dextræ, jugo valv. sinist. congruente, situm; impressione musc. ovato elongata, prope marginem cardinalem posita; margine interiore valvarum undique acute dentato.*

Shell generally moderately curved, always very narrow, but often growing to a very considerable thickness. The ribs are numerous and sharp, irregularly dichotomous, somewhat more raised on the upper convex than on the concave edge and occasionally ornamented with two or three rows of tubercles. The margins of both valves are very strongly dentated. The beaks are depressed and generally slightly twisted, the auricles being either developed of small size, or nearly obsolete. On the anterior portion of the concave side the ribs are always simple, slightly curved, very much resembling those of *O. unguolata*. The ligament of the right valve is lodged in a deep groove which corresponds to a flattened

ridge of the other valve. The muscular scars are situated very close to the hinge; they are of an elongately oval shape, the upper portion being usually covered up by a thin lamina extending below from the hinge-margin.

Localities.—Coonum (in a brownish calcareous rock, very common); south-east of Veraghoor; Odium, Poodoor, Moraviatoor, Kullay, &c., mostly in a brownish limestone.

Formations.—Trichinopoly and Ootatoor groups. The Indian specimens perfectly agree with those from Europe. The species does not generally grow to a great length; 120—150 m. m. being a large size, but these specimens have sometimes a great thickness. One specimen from Kullay in our collection is 150 m. m. long and 80 m. m. high in the middle of the valves.

O. carinata maintains in Europe a somewhat lower horizon than the two following species; exactly the same is the case in India. It is a characteristic fossil of the middle series of cretaceous deposits (*Carentonien* and *Rotomagien* of Coquand). It has been noticed in these beds almost throughout Europe, in Africa and in Asiatic Russia.

5. OSTREA [ALECTRYONIA] PECTINATA, *Lamarck*, Pl. XLIX, Figs. 1—2.

1810. *Ostrea pectinata*, Lam., Ann. du Museum, viii, pl. 165,—*eadem* Coquand, Mon. Ostr. cret., 1869, p. 76, cum synon. (*O. frons*, Park., et *prionata*, Goldf., et auctorum).

O. [Alectr.] testa angusta, plus minusve curvata, æquivalvi, prope umbones compressiuscula, auriculis inæqualibus, aut bene distinctis aut sub-obsoletis, instructa, auricula externa (seu postica) brevior; valvis costis radiantibus acutis rugulosis, nonnunquam minute striolatis, ad medium simplicibus, deinde sæpe dichotomis, iis in margine convexo supra sub-spinulose elevatis, ad latus verticaliter descendentes ornatissimis; margine valvarum undique crasse dentato; impressione muscul. elongate ovata, ad latus umbonale sub-acuta, marginali.

The shape is in this species rather variable, some specimens are nearly straight, others slightly curved, and again some so strongly bent that the termination almost touched the beaks. The ornamentation of the valves is peculiar, the ribs being simple in the middle, mostly bifurcating at the sides, sloping somewhat gradually on the concave side, but very abruptly on the convex one, on the upper edge of which each rib is generally strongly elevated, occasionally rising almost to a blunt spine. The ribs themselves are much thinner and more numerous than in *O. unguolata*, but stronger and less numerous than in *O. serrata* or in *O. carinata*.

In the broadly attached specimens both the ears are generally well developed, the one on the convex (or posterior) side being smaller than that on the concave side. In other specimens which were attached only by a very small portion of the valve the ears are usually less developed, the posterior one sometimes quite obsolete, the anterior being externally ribbed. The ligamental grooves are

straight or slightly curved; the muscular impression very elongated, obtusely pointed above (or anteriorly,) and marginal.

Localities.—Comarapolliam, Ootacoil, Arrialoore, Poodoopolliam, &c., in a whitish sandstone, or more commonly in a soft white or reddish calcareous rock.

Formation.—Arrialoore group.

This species again is one of the most characteristic fossils of the upper series of cretaceous deposits, (Santonien of Coquand). It was found almost in all parts of Europe, where these deposits have been traced out, as well as in North America and in Northern Africa. Forbes (Trans. Geol. Soc., Lond., vii, p. 157,) already indicated its occurrence in Southern India, referring to a species "allied to, if not identical with, the Greensand *Ostrea prionata*." Many of the Indian specimens attain a length of 200 m. m., and the greatest height of both valves sometimes reaches 100 m. m.

6. OSTREA [ALECTRYONIA] UNGULATA, *Schlotheim*, Pl. XLVII, Figs. 3—5.

1813. *Ostracites unguatus*, Schlotheim, Taschenbach, vii, p. 112.

1846. *Ostrea tegulana*,* Forbes, Trans., Geol. Soc., Lond., vii, p. 156, pl. xviii, fig. 6.

1847. „ *Ponticeriana*, d'Orbigny, Voy. d'Astrolabe, Paléont., pl. 5, figs. 45-46.

1869. „ *ungulata*, Coquand, Mon. *Ostrea* cret., p. 58, cum synonym.

Ost. [*Alectr.*] *sigmoidea*, *angusta*, *æquivalvi*, *ad umbones compressiuscula*, *auriculis lateralibus irregularibus*, *paulo expansis seu obsoletis*, *valvis area mediana angusta*, *deplanata*, *lævigata*, *leviter undulata*, *lateribus abruptis*, *plicis fere verticalibus crassis et ad marginem dentatis munitis*; *auricula latiuscula prope umbones in latere concavo sita*, *plicis angustioribus acutis*, *modice curvatis*, *instructa*.

This species is characterised by the plain and smooth median space which runs the whole length of the valves, the sides being abrupt, sometimes almost vertical, and ornamented with single thick ribs which are along the middle generally furrowed, on account of the strongly projecting teeth of the opposite valve. On the convex side the ribs gradually increase in thickness from the umbones, but on the concave side there is a somewhat expanded area, stretching from the beaks to more than one-third the length of the shell, covered with slightly curved, thin, and sharp ribs. On the internal side of this expansion lies the muscular scar which is elongately semi-ovoid, externally with a convex and internally with a concave margin. The valves are narrow and high about the middle, somewhat compressed near the umbones, both of which are curved, and internally provided with the usual ligamental groove.

Localities.—South-east of Ootacod, near Valore (rare); near Pondicherry (common), in a whitish or bluish grey sandstone.

Formation.—Arrialoore group.

The species is a characteristic fossil of the upper cretaceous beds (Campanien apud Coquand) of almost all parts of the world. It has been found all over

* Errore-typico *O. tegulacca* et *tegulacea* apud Coquand, Monog. Ostr. cret., pp. 58 et 212.

Western Germany, in France, England, North America, (*O. larva* of Lam.), Northern Africa, Poland (near Lemberg), Russia, Asia Minor, Arabia, &c. Forbes and d'Orbigny both proposed a new name for the Indian fossil, but its identification with the European one has been already pronounced by Coquand, a conclusion to which I also arrived already some few years previous when I had an opportunity of examining Forbes' and d'Orbigny's original specimens.

7. OSTREA [ALECTRYONIA] ARCOTENSIS, *Stoliczka*, Pl. XLIII, Figs. 3—7.

Ost. [Alectr.] testa parva, irregulariter sub-ovata, inæquivalvi, valva inferiore modice convexiuscula, ad umbonem plus minusve obtusatum sessili, val. sup. aut paulo elevata aut planiuscula; utraque radiatim crasse costata, costis crassis, sub-acutis, simplicibus vel dichotomis, sub-æqualibus, sub-lævigatis, striis nonnullis incrementi distantibus transcendentibus, ad marginem oblique terminantibus; margine ventrali minute plicato, intus multidentato, reliquo crassius dentato; area ligamentali modica, sub-triangulari, in valva inf. medio excavata, in valv. sup. plana; impress. musc. excentrica, postica, haud procula margine vent. sita, transversaliter sub-semicirculari; impress. pall. dorsaliter nonnunquam plicatula.

A small, sub-ovate, slightly bent species, the lower valve of which is moderately convex, the upper more or less flattened. Both valves are covered with numerous radiating, sub-equal, somewhat obtuse, ribs, crossed at certain intervals by a few lamellar striæ of growth and terminating obliquely near the margin, which is strongly toothed, except at the ventral side, where the denticulation is much finer and more numerous than anywhere else. In ornamentation, and partially also in form, this species very closely resembles *Ost. Villei*, Coquand, from Algiers, (Monog. Ostr. cret., 1869, p. 27), and I would have identified both were it not for the very different shape of the muscular scars, which in the Algerian species are much more transversally elongated and placed more posteriorly.

Localities.—South-east of Arrialoor (in grey sandstone), north of Poodoopolliam, in a white calcareous sandstone.

Formation.—Arrialoor group.

8. OSTREA ACUTIROSTRIS, *Nilsson*, Pl. XLV, Figs. 1—6.

1827. *Ostrea acutirostris*, Nilsson, Petr. Suec., pl. vi, fig. 6.

1869. „ „ Coquand, Monog. Ostr. cret., p. 75.

Ost. testa aut elongata, aut irregulariter late ovata, inæquivalvi; valva inferiore sessili, convexiuscula, concentrice crasse undulatim lamellosa et striata, radiatimque sub-costulata, costulis pliciformibus, æquidistantibus, sæpe indistinctis et lateraliter obsoletis; umbone producto, rostrato, nonnunquam paulum incurvato; area ligamentali medio fossula profunda instructa; valva superiore sæpissime paulum minore, irregulariter planulata aut sub-convexiuscula, concentrice lamellata et striata, haud radiatim

costata; umbone depresso, obtuso, saepe indistincto; area ligament. lata, medio vix excavata; impress. musc. excentrica, prope marginem ventralem sita, plus minusve ab umbone remota, late semi-ovata; imp. palliali undique crasse plicata, sub-marginali.

A more or less elongated or largely ovate species with unequal valves, the lower attached valve being principally characterized by the strongly produced and occasionally somewhat twisted umbo, and both by the numerous strong concentric plications and the crenulated, sub-marginal pallial impression. The lower valve has, as noted by Goldfuss, indistinct radiating ribs, generally obsolete at the sides of the valve; the upper valve is only marked with concentric striæ or plications, and its umbo is always obtuse and truncated, the apex being sometimes also slightly bent towards the ventral side. The muscular scars are generally of a broadly semi-ovate shape, placed rather near the ventral margin, but sometimes nearer to, sometimes more remote from, the beaks.

Localities.—Near Arrialoor, Authicoodicaud, Olapaudy, &c.; in whitish sandstone.

Formation.—Arrialoor group.

Ost. acutirostris is found in Europe in the upper cretaceous beds (Santonien of Coquand); it has been recorded from various parts of France, from near Brighton in England, from Maastricht and Aachen, from Sweden, from Galicia, and it also occurs in the same beds in Algiers.

9. *OSTREA TELUGENSIS*, *Stoliczka*, Pl. XLIX, Figs. 3—4; Pl. L, Figs. 1—2.

Ost. testa irregulariter sub-rotundata, valvis sub-æqualibus, deplanatis, varie flexis, antice angustatim productis, superficie concentrice lamellosis et striatis, lamellis plus minusve distantibus, ad marginem accumulatis; umbonibus obtusatis, tumidulis; area ligamentali lata, medio excavata; impress. musc. semi-circulari, aliquanto excentrica.

The valves are sub-equal and flattened, roundish, with the ventral side somewhat narrowly produced; the surface is only marked with somewhat distant lamellæ of growth; the beaks are obtuse, internally with a large ligamental area, excavated in the middle of both valves, but, as usually, more so in the lower than in the upper valve. The muscular scars are large, nearly semi-circular, excentric, placed somewhat nearer to the ventral than to the dorsal side.

Locality.—Near Comarapolliam, in a light coloured calcareous sandstone and in a conglomerate.

Formation.—Arrialoor group.

This species closely resembles Coquand's *Ost. Pasiphaë* (Monog. Ostr. cret., 1869, p. 173), differing from it by the ventral margin being more produced, and the concentric lamellæ apparently coarser and more distant from each other.

10. OSTREA ZITTELIANA, *Stoliczka*, Pl. XLIV, Fig. 4.

Ost. oblique rotundate sub-quadrangulari, compressa, sub-æquivalvi, valvis marginibus cardinalibus longis, antice rectiusculis, postice oblique descendentibus, instructis, in superficie concentrice sub-costulatis et sulcatis, valv. inferiore altera paululum convexiore et crassiore, prope umbonem affixa; umbone obtuse projiciente, intus fossula ligamentali excavata instructo; valva sup. tenuiore, umbone vix prominulo, area ligamentali angusta, medio vix depressa.

Only the single figured specimen has been found of this interesting shell, which is closely allied to Zittel's *Ostrea Madelungi*, identified by Coquand with *Chalmasia (Vulsella) Turonensis* of Dujardin (see p. 397). I do not think that the identification of Zittel's species is correct, though it does not show any place of attachment on either of the valves. *O. Madelungi* differs from *Zitteliana* by having the concentric ribs obliquely distinctly quadrangular, while in the Indian species the concentric sulcations are distinctly rounded and the posterior cardinal edge is not so much prolonged and so straight as the anterior. Our specimen shows a triangular ligamental area with a median groove in the lower valve and a very narrow and flat ligamental area in the smaller valve. The structure of the shell does not differ from that of other *Ostreæ*.

Locality.—Vylapaudy, in a brownish sandstone.

Formation.—Arrialoor group.

XLVI. *Family*,—*ANOMIIDÆ*.

The animal of *Anomia*, and of its close allies, has the mantle margins quite separated, except at the hinge, its edges provided with one to three rows of fine cirri or filaments; one pair of curved gills on each side, unsymmetrical, united posteriorly, each of the outer laminæ furnished with a broad reflexed and free margin; palps small, striated, or almost obsolete; lips elongated, narrow, thin; foot short, sub-cylindrical, somewhat expanded at the end; byssal muscle strong, attached by two unequal branches to the convex valve and passing through a foramen of the other valve, sometimes secreting a shelly or horny lamina at the end, or a byssus; adductor muscle small, sub-central, its impression sometimes partially confluent with the usually larger and sub-equal pedal scars; a small impression also exists near the beaks, it is said by Woodward to be produced by the gill-suspensor, though that muscle rather supports the lips than the gills; pallial line continuous; the sexes are said to be distinct, ovary extending into and partially combined with the right mantle lobe; ventrical free, not passed through by the rectum.

The shells are of an irregularly ovate or roundish shape, much depending upon the form of the object to which they attach themselves, inequivalve, upper valve always more or less convex, lower mostly flat, or concave, sometimes smaller and thinner than the other one, with a more or less complete perforation near the beak, (sometimes closed ? in adult state); ligament internal, attached to a thickened

margin or dental processes of the flat valve corresponding to one or two ligamental furrows of the other valve; muscular scar single, pedal impressions distinctly double or single, sometimes apparently absent.

All the *ANOMIIDÆ* have a comparatively thin shell of a subnacreous, lamellar, and often punctated structure, resembling that of the Brachiopoda.

Having separated the *PLACUNIDÆ* as a distinct family, I include in the *ANOMIIDÆ* all those forms which have one valve flatter than the other and usually perforated. Only in one fossil genus (*Diploschiza*) are both the valves perforated, but there are again some other genera which show no perforation at all. From the study of the shell of *Carolia*, which apparently has when young a distinct foramen, and when adult only an internal groove indicating it, it appears probable that most of the genera have in their young state a small perforation, or emargination, in the lower valve.

The fossil representants of this family are not numerous, the shells being too thin to be well preserved under ordinary circumstances. Some peculiar forms are found already in palæozoic beds, but the family attains a geological importance only with the appearance of *Placunopsis* in the jurassic rocks. From cretaceous rocks several peculiar genera have been described, but true *Anomia* also occur. The species from tertiary beds are more satisfactorily identified with recent genera, although, as a rule, the determination of the fossil species is very difficult, because the upper convex valve, (which is the only one generally found preserved), is externally in all the genera almost quite similar, and the opportunities of examining the internal form of the ligamental pits are far from numerous, and still fewer those of finding the smaller valve attached to the larger one.

According to geological history the genera arrange themselves in the following order: *Limanomia*, (Devon.); *Anomianella*, (Carb.); *Placunopsis* (Jur.); *Paranomia*, the peculiar *Cyclostreon* and *Diploschiza*, (Cret.); *Carolia*, (Eoc.), *Pododesmus*, *Placunanomia*, *Anomia* and *Ænigma* (recent). *Anomia* is recorded already from the jurassics and continues through all the successive formations.

The recent species may be estimated at about 50, but the amount of variation of certain species appears to be very great, and some authors admit barely more than one-half of the number mentioned. They possess a general geographical distribution and range from the littoral zone to several hundred fathoms.

As regards the zoological affinities of the present to the previous family the genera can be arranged as follows:—

1. *Placunopsis*, Morr. and Lycett, 1853, (Moll. Great Ool., pt. ii, p. 5). Sub-orbicular, generally somewhat irregular, inequivalve; larger valve convex, with small sub-marginal, sub-median beak, and mostly ornamented with radiating ribs or striæ; smaller valve flat, free, or attached to foreign objects; hinge toothless, with a small cartilage pit in each valve; muscular scar large, sub-elliptical, sub-central. Type, *P. Jurensis*, Roem. All the species as yet known are from jurassic deposits. The inequality of the valves and absence of hinge-teeth, or any other internal processes, separate this genus from the next one, but it is not certain

whether all the jurassic species referred to *Placunopsis* agree with the characteristics above noticed; many of them appear to belong to *Anomia*, and doubts are expressed on this point even regarding the type species, *P. Jurensis*.

2. *Cyclostreon*, Eichw., 1867, (Leth. ross., x^{me} livr., p. 406). Shell obliquely ovate with attenuated obtuse beaks, inequivalve; one (right?) valve convex; the other (left?) smaller, flat or concave, with a small transverse ligamental groove at the apex; in the convex valve there is only a small lateral groove below the beak, placed somewhat anteriorly; both beaks are truncate and appear to indicate an attachment to foreign bodies; muscular impression indistinct, represented by a marginal zone which surrounds the cavity of the convex valve. In the figure given by Coquand (Monog. *Ostrea*, pl. xiv, figs. 10-14), the whole of the internal part of the valves seems to be occupied by one large impression. Type, *Ostrea Nilssoni*, Hag., (= *Ostrea plicatuloides*, Leymerie). This shell greatly resembles *Hemiplicatula*, but is stated to have no such hinge or cartilage ribs as are characteristic of that genus.

3. *Paranomia*, Conrad, 1860, (Journ. Acad. Nat. Soc., Phil., iv, p. 290, and Am. Journ. Conch., iii, p. 8). Irregular, inequivalve; one valve flattened or slightly concave, hinge of lower valve with a broad, irregular, triangular tooth or plate, flattened or slightly convex, with sharp margins and an anterior, compressed, small, but prominent tooth; muscular impression situated towards the ventral margin in a line with the apex, or nearly equidistant from the anterior and posterior ends. Type, *Placunanomia Saffordi*, Con., from cretaceous rocks of Tennessee. There are only two other cretaceous species which Conrad refers to the same genus; it seems to be closely allied to Philippi's *Pododesmus*. The convex valve has no teeth or appendage and is generally radiately ribbed; the flatter valve is often attached near the umbo to other objects and very thin, but not perforated.

4. *Carolia*, Cantr., 1838,* (Bull. Acad. Bruxelles, v, p. 111, *Hemiplacuna*, Sow., 1849, teste Gray). Shell sub-orbicular, sub-equivalve, compressed, in general structure, and in the fine radiating ornamentation, resembling *Placuna*; one valve flattened, the other slightly convex, with a distinct sub-marginal umbo; hinge in the flatter valve consisting of a strong sub-triangular tooth, somewhat irregularly plicated at the base, above raised, and on either side with a sloping elongated surface to which the ligament attaches itself, corresponding in the other valve to two diverging flat ridges joined below the umbo; the whole of the upper hinge margin is flattened and concentrically rugosely striated. A short groove runs from the umbo to the margin (similar to that of *Ænigma*), and at certain stages of age there appears to be a temporary short vertical slit below the tooth of the flatter valve; muscular scar round, sub-central. Type, *C. placunoides*, Cantr., (supposed to be) from tertiary beds of Egypt. Woodward (Man., p. 410,) states that there is in the young shell of this type species a narrow vertical byssal foramen below the hinge-tooth of the flatter valve, but that it

* Non *Carollia*, Gray, 1838.

becomes closed in the adult shell. The same author also says that there are three species known, adding "America?" as locality.

Sowerby's type species of *Hemiplacuna* (*Rozieri*, G. B. Sow.), figured in Descript. sc. de l'Egypte, is probably the same species as Cantraine's. Gray, in describing the genus (Proc. Zool. Soc., 1849, and Cat. *Placent.* and *Anom.* Brit. Mus., 1850, p. 4), says that on the inner surface of the right valve, just in front of the base of the process which supports the cartilage, there is a small, shallow, roundish pit with a short furrow towards the centre of the shell, which is evidently a rudimentary representation of the sinus found in the genus *Anomia*. This rudimentary sinus is not visible on the outer surface of the shell. Cantraine makes no reference to the pit or groove, but the latter is distinctly indicated in his figure of the flatter valve.

5. *Pododesmus*, Phil., 1837, (Handb. der Conch., p. 380). Irregular, inequivalve, with dissimilar umbones, that of the lower, flatter, and adnate valve spirally twisted, with a raised lamella, separated from the margin, bearing the ligament which is lodged in a corresponding groove of the other valve; muscular scar oval. Type, *P. decipiens*, Phil., from Cuba.

Gray, Reeve, and other authors identify this species with *Placunanomia rudis*. Brod. and H. and A. Adams quote this last species, besides two others, under the name *Pododesmus*, as sub-genus of *Placunanomia*. I am not aware that the specific identification of *P. rudis* and Philippi's type of *Pododesmus* has been satisfactorily proved, namely, that the latter should be an advanced stage of age of the former; but Philippi distinctly says that it differs "from *Placunanomia* by the lower valve not being perforated, by the want of the two internal hinge teeth," &c. I can hardly believe that in the face of such an assertion Philippi would have overlooked the perforation of the lower valve of *Pl. rudis*.

The characteristic of *Pododesmus* very closely coincides with that of Conrad's cretaceous *Paranomina*.

6. *Placunanomia*, Brod., 1832. Irregular, inequivalve, attached by the lower, flatter valve which has a perforation near the upper end, the anterior part of the valve being somewhat twisted and produced into a bilobed raised tooth on which the ligament is situated, and which corresponds to two ligamental grooves of the other valve; muscular scar single in the lower, double in the upper valve. Type, *P. macrochisma*, Desh.

Reeve described in 1859 (Iconica, vol. xi,) 14 recent species; they are mostly from the American and Australian seas. H. and A. Adams quote 12 species and place three of them in *Pododesmus*, of which they call *rudis* the type, possessing a small foramen, and for the rest they adopt the sub-generic name *Monia*, Gray, having a larger foramen, slightly embracing the large and thin plug. The distinction seems to me quite unnecessary.

The difference of *Carolia* from *Paranomina* rests almost only in the absence of perforation in the lower valve of the former genus.

7. *Limanomia*, Bouchard, 1850, teste Gray, (Cat. *Placent.* and *Anomiadæ*, Brit. Mus., 1850, p. 21). "Shell adherent, longitudinal, sub-equivalve, inequilateral; umbo curved to the right (regularly curved on each side); cardinal edge transverse, oblique, inclined to the right; valves thin near umbo, slightly radiately ribbed; lower valve with a sub-triangular notch near the umbo, under the ear; cartilage? muscular scar? plug triangular, calcareous, with a narrow, scalariform impression." Type, *L. Grayana*, Bouch., from Devonian limestone near Boulongere. Three other species are indicated by Gray from the same beds.

In external shape this genus is stated to resemble a *Radula* (= *Lima*), but the lower valve is adherent and provided with a perforation, as in *Anomia*.

8. *Anomianella proteus* is figured by Rychholt from the carboniferous beds of Belgium; it is an ovate, thin shell, found attached to other shells; there appears to be no perforation in the lower valve, (*vide* Mem. cour., Acad. Belgique, xxiv, 1852, Rychholt Mel. Paléont., pl. x, figs. 21—23). I have not met with any detailed notice of the characters of this shell.

9. *Anomia*, Linné, 1757. Somewhat irregularly sub-orbicular; lower valve attached, flattened or concave, perforated and notched near the minute beak; upper anterior or posterior part of the valve separate from, and often partially overlapping, the thickened cardinal edge to which the ligament is internally attached; plug thick, entirely shelly, and free from the notch of the foramen; upper valve more or less convex, internally with three sub-central muscular scars. Type, *A. Ephippium*, Linné. There are about 35 recent species known of general distribution.

For *A. Elyros* (Proc. Zool. Soc., 1849, p. 118), which has the thickened ligamental edge rather produced, the two lower scars of the larger valve small, the upper one large, and is of a roundly sub-quadrangular shape, Gray proposed the sub-generic name *Patro*. The distinction from typical *Anomiæ* seems insignificant.

10. *Ænigma*, Koch, 1845. Shell irregularly oblong or rounded, very thin, inequivalve; lower valve flat, with an excentric foramen, covered by a very thin shelly lamina of the plug; the lobes of the foramen partially overlapping each other, but not closed; their hind edge for the ligamental attachment barely thickened; a partially open groove also runs from the beak of the upper, more convex, valve to the edge; upper scar large; two lower smaller and distinctly separate. Type, *Æ. enigmatica*, Chem.

This form appears to deserve a generic distinction from *Anomia*; it inhabits brackish waters or estuaries. Reeve acknowledges only one species which lives on foliage and on trees in the Mangrove swamps. A similar, and probably distinct species occurs on the coast of the Bay of Bengal; it was first met with by Dr. J. B. Baxter at the Mutlah River (Port Canning, south-east of Calcutta). I have also found it alive in the same locality, flatly attached with the entire lower valve to old bricks, &c., which are only submerged during high water. The animal slightly differs from that of *Anomia*. The same species also occurs on the Burma coast and at Penang.

11. *Diploschiza*, Conrad, 1866, (Am. Journ. Conch., II, p. 77). Sub-ovate, inequivalve; smaller valve concave, both of a laminated structure and with truncate, deeply-notched or emarginated beaks. Type, *D. cretacea*, Con. (l. cit., p. 77, pl. 9, figs. 2-3).

Conrad says that "the shell seems to have been attached by the umbo of the larger valve, the truncature of which reminds us of the truncated beak of *Terebratula*." It is a curious shell, and, if perfect, would indicate a greater similarity to a Brachyopod form than any I am acquainted with.

LIST OF CRETACEOUS SPECIES.

- 1.—*Anomia Neocomiensis*, d'Orb., Pal. Franç. terr. cret., iii, p. 754, pl. 489, figs. 1—3.
- 2.—*A. lavigata*, Sow., (Trans., Geol. Soc., Lond., iv, pl. 14, fig. 6,) from the lower Greensand and Neocomien.
- 3.—*A. costulata*, Rœm., (Nordd. Oolit., Nachtrag, 1839, p. 24, pl. 18, fig. 5,) from the Hills.
- 4.—*A. convexa*, Sow., (Trans., Geol. Soc., Lond., iv, pl. 14, fig. 7,) from lower Greensand.
- 5.—*A. pseudo-radiata*, d'Orb., Prod. ii, p. 84, = *radiata*, Sow., (non Risso), Trans., Geol. Soc., Lond., iv, pl. 14, fig. 5.
- 6.—*A. papyracea*, d'Orb., Pal. franç. terr. cret., iii, p. 755, pl. 489, figs. 7—10.
- 7.—*A. sub-truncata*, d'Orb., (Prod. ii, p. 171, = *A. truncata*, Geinitz, (non Linné,) Characteristic Sächs. Kreid., pt. iii, 1842, p. 87, pl. 19, figs. 4-5,) from Bohemia.
- 8.—*A. semiglobosa*, Geinitz, (Quadersandst., 1850, pl. xi, figs. 6—9), from Kieslingswalda.
- 9.—*A. lamellosa*, Rœm., (Nordd. Kreidef., p. 49, pl. 8, fig. 3).
- 10.—*A. granulosa*, Rœm., (*ibid.*, pl. 8, fig. 4), from Rügen. Only the convex valve of this species is known; the hinge margin is said to be thickened, with 3-4 vertical, conic, prominences. This would indicate that the species in question rather belongs to the *SPONDYLIDÆ* than to the *ANOMIIDÆ*.
- 11-12.—*A. subradiata* et *excissa*, Reuss, (Boehm. Kreidef., pt. ii, p. 45, pl. 31, figs. 15, 18, 19).
- 13-14.—*A. pellucida* and *verrucifera*, Müller, (Monog. Petref. Aachener Kreidef., Suppl., 1859, p. 7, pl. vii, figs. 4-5).
- 15.—*Placunopsis? ciliata* (= *Orbicula ciliata*, Müller), Bosquet in Starings Bodem van Nederland, II^{de} deel, fossil fauna, &c., No. 526).
- 16.—*Anomia refulgens*, Coq., Mon. Etage Aptien de l'Espagne, 1865, p. 169, pl. 27, figs. 8-9.
- 17.—*A. forata*, Passy, (*Gryphæa forata*, Seine- inf., pl. 14, figs. 5-6, Coquand, Mon. du genre Ostrea cret., 1869, p. 194).
- 18-19.—*A. Coquandi* et *intercostata*, Zittel, (Denksch. Akad., Wien, xxv, pt. ii, pp. 126 and 127, pl. 19, figs. 8 and 10,) from the Gosau.
- 20.—*A. excentrica*, Coq., (Bull. Soc. Géol. de France, 2nd ser., vol. xvi, p. 1068).
- 21-22.—*A. ephippiiformis* and *distracta*, Eichw., are stated to occur near Khoroshowo in beds believed to be by Eichwald Neocomien, (Leth. ross., xme livr., 1867, p. 411).
- 23.—*Cyclostreon plicatuloides*, Leym., (Eichwald, *ibidem*, p. 407), see p. 475.
- 24.—(*Cyclostreon?*) *Plicatula arachnoidea*, Deslongch., (Mém. Soc., Linn., xi, 1860, p. 124, pl. 18, figs. 38, 39), a very remarkable species, but it is not clear whether the name *Cyclostreon* is applicable to it.
- 25.—*Anomia parva*, Gabb, (Proc. Acad. Nat. Sc., Phil., 1860, p. 198, pl. 3, fig. 5,) from Chili.
- 26-34.—*Paranomia lineata*, Conr., *Saffordi*, Conr., et *scabra*, Morton, *Anomia argentaria*, Mort., *Flemingi*, Meek, *obliqua*, M. and Hayd., *sellæformis*, Conr., *subtrigonalis*, M. and Hayd., et *tellinoides*, Mort., are from North America (*vide* Meek in Smiths. Misc. Coll., No. 177, p. 6).

- 35.—*Anomia lineata*, Gabb, Pal. Calif., vol. i, p. 203, pl. 26, fig. 190.
 36.—*A. Vancouverensis*, Gabb, *ibidem*, vol. ii, p. 202, pl. 33, fig. 102.
 37.—*Placunanomia inornata*, Gabb, *ibidem*, vol. i, p. 217, pl. 32, fig. 288a.
 38.—*Diploschiza cretacea*, Conr., Am. Journ. Conch., ii, p. 77.
 39.—*Anomia variata* is the only species occurring in the South Indian cretaceous deposits.

ANOMIA, *Linné*, 1757, (see p. 477).

1. ANOMIA VARIATA, *Stoliczka*, Pl. XLVIII, Figs. 9—12.

An. testa superiore rotundata seu rotundate ovata, tenui, convexa, sub-lævigata, seu variatim et irregulariter costulata; apice sub-marginali, indistincto, obtuse incurvo; margine cardinali inflexo, intus paulo incrassato; fovea ligamentali parva, transversa.

A small species with the upper valve of an orbicular or roundly-ovate shape, generally strongly convex, nearly smooth, (the surface being probably corroded), or with irregular moderately elevated transverse, curved ribs; the margins are very thin, entire, or slightly undulating, evidently depending upon the character of the surface on which the species is sessile; the beak is indistinct, sub-marginal; the cardinal margin is somewhat inflexed, internally slightly thickened, with an indistinct transverse ligamental groove below the beak. The lower or perforated valve has not been observed.

Locality.—Comarapolliam, in a soft, coarse siliceous sandstone.

Formation.—Arrialoor group.

ADDITIONS AND CORRECTIONS.

Family,—*PHOLADIDÆ*. *Sub-family*,—*TEREDINÆ*.

On page 14, after No. 8, add—

9. *Lyrodus*, Gould, 1870, (Invert. of Massach., 2nd edition, p. 34). This name has been suggested for a small species, *Teredo chlorotica*, the palettes of which are elongated, with the basal portion thin, flexuous, the upper "lyre-shaped," the extreme two-thirds of their length being "covered with a dark crust which has a projecting horn at each angle." The form of these palettes very closely resembles that of *Nausitoria*, when the tip is broken away. It is not improbable that both belong to one and the same genus.

On page 31, line 9 from top, for "Fig. 12," read Fig. 11.

Family,—*MYIDÆ*. *Sub-family*,—*CORBULINÆ*.

On page 35, before "4. Eucharis, Recluz," &c., add—

3a. *Tæniodon*, Dunker, 1851, (Palæontographica, by Dunker and H. von Meyer). Shell ovately elongated, sub-equilateral, smooth, equivalve, and apparently closed, right valve with a cardinal tooth under the umbo extending forwards, left valve with a distinct marginal cartilage pit behind the beak; type, *T. ellipticus*, from liassic beds near Halberstadt (Germany). Dunker says, that the ligament was partially external, partially internal, and that the valves are not gaping. So far, this character would agree with *Eucharis*, but the hinge appears to be different; muscular and pallial impressions have not been observed. The genus is evidently closely allied to *Corbula*, and still more so to *Quenstedtia*, but unless the last named genus and *Eucharis* be better characterized, it will not be possible to form a correct idea of their affinities to *Tæniodon*.

On page 39, before "Sub-family,—MYINÆ," add—

14. *Dorsomya dorsata* is figured by Ryckholt as an apparently new genus from the carboniferous beds of Belgium. The figure represents a cast of an elongately ovate shell, with a convex dorsal and slightly flexuous ventral margin, very inequilateral, the small beaks being almost anterior, two small ovoid muscular scars, one placed quite at the anterior end, the other near the posterior dorsal margin; pallial line in the upper posterior part with an almost horizontal, deep, narrow sinus. The shell resembles *Corbulomya* in shape, but the knowledge of the hinge is essential for its correct generic determination, (*vide* Ryckholt, *Mélanges Paléont.*, 1852, p. 17, pl. x, fig. 20, in *Mém.*, Cour. Acad. Belgique, vol. xxiv).

On page 41, add—

25. *Corbula velata*, Schafh., is according to Gümbel (Neues Jahrb. f. Mineralogie, &c., 1865, p. 149), identical with *Crassatella Penana*, Gümbel, an eocene species, (Bayer. Alpengeb., 1861, p. 662).

Instead of *C. velata* read under No. 25, *Corbula subelegans*, Briart et Cornet, (Descript. mineral., &c., de la meule de Bracquegnies, p. 82, pl. v, figs. 17 and 18, in Mém., Cour. Acad. Belgique, vol. xxxiv).

Family,—*ANATINIDÆ*.

On page 69 under No. 32, *Plicomya*, Stol., 1870, note—

Conrad (Am. Jour. Conch., vol. VI, p. 76,) proposes to substitute for his name *Leptomya* that of *Periplomya*. I do not know the exact date of issue of Part I of vol. VI of the American Journal of Conchology. My name *Plicomya*, substituted for Conrad's *Leptomya*, was published on 8th September 1870, although the portion of letter press containing it was already printed about the end of January of that year, and the MS. had been prepared at least one year prior to it.

Conrad adds the figure of the hinge of the type species (*Periplomya*) *peculiaris*, Conrad, (quoted on p. 73 sub-No. 39). From this it would seem as if there were a thick, oblique tooth in the left valve passing at its base into a thickening of the posterior hinge margin, a fissure would seem to extend from the beak posteriorly; of the other right valve only a median spoon-shaped process is figured below the beak. It is possible that I may be mistaken in the interpretation of right and left valve, but that would not be supported by Conrad's reference on p. 76 loc. cit. If I am, however, correct in the interpretation of the figures, the form could hardly be considered as sufficiently distinct from *Anatina*.

Page 75, after No. 138, insert—

138a. *Pholadomya subcaudata*, Briart et Cornet, (Foss. meule de Bracquegnies, p. 84, pl. vi, figs. 19-20, in Mém. Cour. Acad., Belg., xxxiv), a species very closely allied to *Ph. caudata*, Roem.

Page 76, line 12 from bottom, for 'Figs. 14—15,' read Figs. 14—16.

Family,—*SAXICAVIDÆ*.

Page 84, line 17, from top, after '4. *Paramya*, Conrad,' for '1862(?)' read the year 1838, Foss. of mid. tert. form., U. S., Index p. 88, and Proc. Phil. Acad., 1862, p. 232.

Page 88, No. 59. The name *Panopæa Sancti-Petri*, Ryckholt, is changed by Bosquet into *P. Ryckholti*, (Liste des foss. du mass. crét. du Limbourg, 1868, extr. du descript. geol. de la Belgique par Devalque, p. 17), but there is no necessity for this change. I have, however, accepted the suggested change of a specific name, where it designates two distinct objects to which the species is referred, such as "*montis sancti Petri*."

Family,—*SOLENIIDÆ*.

On page 97, after line 29, insert—

11a. *Solyma*, Conrad, 1870, (Am. Journ. Conch., VI, p. 75). Shell ovately elongated, thin, equilateral, ventricose, right valve with 'two direct approximate

+ What difference does it make when it was printed in 1870? Conrad's name was published in July 1870.

teeth under the beak;' type, *S. lineolatus*, from cretaceous rocks. Conrad states that the genus is allied to *Leptosolen*, though as to form it rather appears to exhibit greater relation to some *TELLINIDÆ*, and as regards the hinge-teeth of the right valve it is allied to *Solecurtus*.

Page 98.—14. *Cleidophorus*. I have again referred to this genus in the Family *SOLEMYIDÆ*, p. 269; it is difficult to decide upon its classification, until the hinge has been made correctly known.

Page 100, after No. 34, add — *Solyma lineolatus*, Conrad, (loc. cit.) from cretaceous beds of Haddonfield, New Jersey.

Family, — TELLINIDÆ.

Page ¹¹⁷177, under 8f, *Linearia*, Con., note some additional information given about the genus in Am. Journ. of Conch., vol. VI, p. 73. Conrad states that when he first proposed the name, he had not seen the hinge of the right valve, which shows "two small diverging, nearly equal teeth, directed obliquely forward, the anterior one very oblique; and two rather long lateral very distinct pits, the posterior one very distant from the apex."

Page 118. '8i. *Tellinimera*.' Conrad (Am. Journ. Conch., VI, p. 73,) writes now *Tellimera*, which name is hardly an improvement upon the original denomination. He considers *T. eborea*, Con., as type, and adds the following characteristic of the hinge of the left valve: 'cardinal teeth two; anterior one \vee (? \wedge -) shaped, nearly direct, or slightly directed anteriorly; the posterior tooth bifid; oblique; posterior lobe thick, and longer than the anterior lobe; cardinal plate comparatively broad laterally, posteriorly channelled; anteriorly with a small pit, apparently for the reception of a lateral tooth.'

On page 119 add—

8o. *Aenona*, Conrad, 1870, (Am. Journ. of Conch., VI, p. 74). 'Equivalved, without fold; hinge character: two compressed, very small, widely diverging teeth in the right valve; lunule very narrow, lanceolate, and marked by a deeply impressed line;' type, *Tellina Eufalensis*, Con., (see p. 124, No. 46). This species is described as a sub-triangular, inequilateral shell, with the hinge margins equally declining, summit (? beaks) not prominent, "left valve furnished with one bifid and one rudimentary cardinal tooth; lateral teeth distinct."

I am at a loss to know why this shell should form a separate genus. The characteristics given by Mr. Conrad could apply as well to about half a dozen of other sub-genera of *Tellina*.

Page 124 add—

42a, 42b. *Tellina multistriata* et *scutiformis*, Briart et Cornet, (Foss. de Bracquignies, pp. 78 and 88, pl. viii, figs. 14-15 and 16-17, in Mém. Cour. Acad., Belg., vol. xxxiv); both belong to *Linearia*.

74a. *Tellina* [*Aenona*] *papyria*, Conrad, from cretaceous beds at Haddonfield, New Jersey, (Am. Journ. Conch., VI, p. 74).

Page 124, 5th line, from bottom, for *T. (Per.) primula*, read *T. [Tellinides] primula*; for further reference see p. 126.

At the end of page 145 add—

6. *Liocyma*, Dall, 1870, (Proc. Bost. Soc. Nat. Hist., xiii, p. 252,) has been proposed for *Tapes fluctuosa*, Gould, (Moll. Massach., 2nd edit., p. 136). It is a small, ovate, concentrically striated, compressed, nearly equivalve and rather thin shell; there are in each valve three cardinal teeth, the middle one cleft; pallial sinus small. I doubt that sufficient reason exists for separating generically the shell from *Pullastra*, as restricted; it does not appear to differ from small, or young, forms of this genus.

Page 147, 6a. *Mercenaria*—

Perkins, in a paper on the Molluscan fauna of New Haven, Part II, &c., (Proc. Bost. Soc. Nat. Hist., Nov. 1869, p. 147,) proposes to substitute for *Mercenaria* a new generic name, *Crassivenus*. I need not repeat what I have already noticed in my introduction, that the recently proposed so-called “rule” of the British Association, rejecting all generic names which have been taken from specific designations, is in its application impracticable, and has no chance of being adopted by naturalists. It must not take retrospective effect.

On page 152 add—

8i. *Artena*, Conrad, 1870, (Am. Journ. Conch., VI, p. 76). Shell “triangular, thick; surface with acute, concentric, prominent ribs; hinge with three cardinal teeth in the right valve, two of them diverging, distant, the anterior one under the apex robust, direct, curved; left valve with three diverging distant teeth; lateral tooth very small, pyramidal; pallial sinus very small and angular.” Type, *Cytherea staminea*, Conrad, (Foss. tert. form., U. S., pl. 21, fig. 1). This appears to be very close to some species of *Dione* and barely different from that sub-genus. Conrad states that it differs from *Cytherea*, (= *Meretrix*), *Caryatis*, and others by the one thick anterior cardinal tooth of the right valve instead of two approximate teeth, ‘and by the two distant thick, nearly equal teeth of the opposite valve,’ &c., but in the above characteristic there are said to be ‘three distant teeth.’

On page 156 note under—

13. *Eriphyla*, Gabb. I quoted as one of the best known species of this genus *Lucina lenticularis*, Goldf. This species is noticed by Bosquet in his Liste des foss. de mass. crét. du Limbourg, p. 16, (Extr. du Prod. d’une desc. géol. de la Belgique, par G. Dewalque, 1868,) as *Dozyia lenticularis*, Bosq., evidently with the object of suggesting it as the type of a new genus.

14. *Gemma*, Desh. Stimpson had already called *Venus Gemma*, Totten, which is the type species of the genus, *Gemma Totteni*, a name which I had previously overlooked. Perkins (Proc. Boston Nat. Hist. Soc., November 1869, p. 148,) suggests the new generic name *Totteniana** “according to the British

* The author might at least have so far conformed to the obvious rule of using the name *Tottenia*, unless he has discovered that Mr. Totten was wrong in originally spelling his own name (see Tryon in Am. Journ. Conch., VI, p. 177).

Association Rules." I need not repeat that this name has no claim to be adopted, for reasons already explained.

On page 158, note—

18. *Thetironia*. Regarding some additional characters of this genus, as observed in an Indian species, subsequently discovered, see further on (p. 485).

19. *Aeora*, Conrad, 1870, (Am. Journ. Conch., VI, p. 72). Shell roundly ovate; right valve with three diverging cardinal teeth, posterior one bifid; cardinal plate broad, deeply channelled anteriorly, with a compressed, lateral tooth in the middle of the channel; plate deeply channelled posteriorly. Left valve with three diverging cardinal teeth, the anterior one \vee (? \wedge -) -shaped, oblique; one distant anterior lateral tooth with a channel above, parallel with the cardinal margin; nymphæ crenulated on the upper margin, a distant, narrow, channel on the posterior hinge-plate; pallial sinus deep, reaching to a point in a line with the posterior extremity of the posterior cardinal tooth; rounded and somewhat ascending; type, *Ae. cretacea*, Con., loc. cit., pl. 3, fig. 8.

Conrad says that this genus is nearly related to *Isodoma*, but I rather think it should be placed between *Cyclina* and *Thetironia*. The type species in general external characters of the shell also closely resembles some *Cyprimeria*.

20. *Scaldia*. Two species, *S. Lambotheana* and *Kickxiana*, are described under this apparently new generic name by Ryckholt from carboniferous beds of Belgium. The shells are equivalve, roundly ovate, moderately tumid, with concentric striæ of growth: muscular scars two, anterior larger than the posterior; pallial line with an angular, somewhat ascending sinus, as in *Dosinia*; hinge of left valve with a single, tubercular, cardinal tooth below the umbo. (*Vide* Ryckholt's Mel. paléont., 1852, p. 17, pl. x, figs. 24-28, in Mém. Cour. Acad., Belg., vol. xxiv).

On page 165 add—

109a. *Venus Nystii*, Briart et Cornet (Foss. de Bracquegnies, p. 76, pl. viii, figs. 11-13, in Mém. Cour. Acad., Belg., vol. xxxiv,) is evidently an *Eriphyla*, and very closely allied to *E. lenticularis*, Goldf. The latter species is a little more inflated, but specimens with more convex valves (*vide* pl. vi, fig. 13,) are also often met with, and these hardly differ from the Bracquegnies form.

109b. *Venus Lucina*, Briart et Cornet, (*ibidem* p. 77, pl. viii, figs. 22-23,) is to all appearance a *Cyprimeria*.

109c. A species allied to *Venus* (? *Baroda*) *Royana*, d'Orb., is noticed by Gümbel from the lower beds of the Greensand at Neukelheim (Bavaria) (see Gümbel's Ostbayer. Grenzgeb., 1868, p. 764).

On page 166 add—

189a. *Aeora cretacea*, Conrad, from cretaceous beds at Haddonfield, New Jersey (see above).

On page 181 add to the synonyms of Eriphyla lenticularis, (Goldf.)—

1868. *Dozyia lenticularis*, Bosquet, Liste des foss. de mass. crét. du Limbourg, p. 16, extr. du Dewalques' desc. géolog. de Belgique.

On page 182 add description of the following Indian new species—

THETIRONIA, *Stoliczka*, 1870, (see p. 158).

THETIRONIA IGNOBILIS, *Stoliczka*, Pl. L, Fig. 3.

Th. testa rotundate ovata, inflata, æquilaterali, valvis tenuissimis, in superficie concentricè striatis, et radiatim minute punctatis; sinu palliali profundo, postice angustatim fere usque ad apicem umbonis extenso; valva dextra dentibus cardinalibus duobus approximatis, et fossula laterali postica, remota, v. sinistra dentibus cardinalibus tribus, sub-æqualibus et uno minimo postico, instructis.

Only two specimens of this interesting species were contained in the old Madras collection. Impressions of the shell indicate that it must have been very thin, concentrically marked with minute striæ of growth and radiately punctated. The pallial impression, or at least what is taken as such, is perfectly distinct; the posterior sinus reached almost to the end of the beak. The muscular scars are ovate, marginal, placed rather high up towards the beaks. The left valve shows impressions of three closely approximate cardinal teeth, the median is largest, directly under the beak, and may have been bifid, the two others slightly prolonged laterally; there is besides a distinct impression of a somewhat remote posterior lateral pit, but no distinct anterior lateral pit or tooth is traceable. The right valve indicates two very approximate cardinal teeth (or three fossets), and a very minute posterior lateral tooth. The character of the shell, its ornamentation, and partially also the position of the cardinal teeth, most markedly resembles that of *Fimbriella* (see p. 246), and it will be interesting to see in what relation these two genera, as now accepted, stand to each other.

Locality.—Pondicherry. The two specimens from which the above notes were derived have been received from Madras. They are in a bluish grey siliceous sandstone together with fragments of *Antale Arcotinum*, Forbes, and some species of *Anisoceras*.

Formation.—? Valudayúr group.

Family.—Glossidæ.

On page 192 add—

16. *Veleda*, Conrad, 1870, (Am. Journ. Conch., VI, p. 74). Ovately elongated, tumid, posteriorly ridged from the umbo, concentrically striated on the surface, equivalved; "left valve with a \vee (? \wedge -) shaped cardinal tooth under the apex and three compressed teeth, posterior one elongated and parallel with the dorsal margin, cardinal plate channelled, deeply so anteriorly." Type, *V. linteæ* (*Cardium linteum*, Conrad, Journ. Acad. Nat. Sc., Phil., 2nd ser., vol. iv, p. 278, pl. 46, fig. 17). The description of the hinge-teeth of the left valve appears to indicate a relation of this genus to *Cyprina*, in which the median cardinal tooth is largest, as in *Cicatreæ* (see pl. x, fig. 2); but the statement is not clear whether by the

posterior elongated tooth is meant a lateral tooth or not; in any case it would seem to replace it when it extends 'parallel with the dorsal margin.' Until this point has been cleared up, and the relation of the shell to *Cyprina* and *Cicatrea* ascertained, it may be no advantage to replace Conrad's name by another one, for the name *Veleda* had been used already in 1859 by Blackwall for a species of spiders.

On page 193, under 12.—Cyprina angulata, Sow., note—

Briart and Cornet (Foss. de Bracquegnies, p. 68, pl. viii, figs. 26-28, in Mém. Cour. Acad., Belg., vol. xxxiv), give a figure of the hinge of both valves of a species which they say is identical with Sowerby's *C. angulata*, of which they compared a specimen from Blackdown, and the hinge of which is badly represented by Sowerby in his Min. Conch., pl. 65. Briart and Cornet's figures show the species to be a *Venilicardia*, noticed (p. 190) as a sub-genus of *Veniella*.

On page 194 add—

50a. *Cyprina procæna*, Gümbel, (Ostbayerisch. Grenzgeb., 1868, p. 765), from the Greensand at Neukelheim (Bavaria). The tumid form of the shell closely resembles that of an *Isoarca*, hinge unknown.

50b. *Cyprina sub-rostrata*, Gümbel, (Correspondenz Blatt des Zool. Mineral. Ver. zu Regensburg, vol. xxii, 1868, p. 65), has been proposed for the species described by Geinitz as *C. rostrata* in Verst. von Kieslingswalde, p. 13, pl. ii, fig. 12).

Under No. 69, Isocardia modiolus, Nilss., note—

Ryckholt (Mél. paleont., Part 1st, 1852, p. 131,) considers this species to be a *Lithodomus*.

69a. *Isocardia Sowerbyi*, Briart and Cornet (Foss. de Bracquegnies, 1858, p. 70, pl. vii, figs. 17-18). The general form of the shell resembles that of a *Meiocardia*, but also that of *Goniosoma* and some species of *Opis*. As the hinge is unknown, a correct generic determination cannot be attained.

On page 195 add—

129a. *Venilia elevata*, Con., (Am. Journ. Conch., VI, p. 74, pl. 3, fig. 7), has a form resembling that of *Meiocardia*, but the hinge is unknown.

129b. (*Veleda*) *linteria*, Con., is noticed as *Cardium* [*Lævicardium*] *linteria*, on p. 215, sub-No. 146.

On page 199, under CYPRINA [CICATREA] CORDIALIS, for Fig. 1, read Figs. 1-2.

Family,—CARDIIDÆ.

On page 208 add after the third line from top—

Criocardium, Conrad, 1870, (Am. Journ. Conch., VI, p. 75). "Multiradiate; interstices spinose, ribs smooth; anterior lateral tooth long and prominent." This sub-genus, Conrad says, presents a singular deviation from the character of recent spinose species, in having long, slender spines in the interstices between the ribs, while the ribs are smooth. Type, *C. dumosum*, Conrad.

I am not certain whether the same objections which I have recorded against adopting *Granocardium* should not be repeated in the present case. The fact is, that numerous recent and fossil *Trachycardia* have the spines placed so low laterally on the ribs that they almost appear to originate between the ribs, and have quite the appearance of doing so when the furrows are not perfectly well exposed from the rock in which the shells are found imbedded. I cannot easily imagine what kind of a mantle-edge the animal must have possessed in order to produce sharp radiating ribs and again in the interstices long spines.

Conrad says that Gabb's *C. multiradiatum* and *C. Raulinianum* also belong to the same sub-genus. I do not think any necessity exists for separating them from the sub-genus *Pectunculus* or *Trachycardium*. The latter species has been by an oversight suggested to belong to *Lævicardium* (on p. 213, sub-No. 51).

On page 213—

Under No. 65. *Cardium Ottonis* (haud *Otto*). Gümbel, (Ostbayerisch. Grenzgeb., 1868, p. 765,) gives a figure of, and some additional information about, this species.

65a. *Cardium (Cerastoderma) Eggeri*, Gümbel, (*ibidem*, p. 765, fig. 4,) from Marterberg (Bavaria).

65b. *Cardium Priesenense*, Gümbel, (Abhandl. Münchner Akad., x, p. 569,) from Priesen in Bohemia. The species is said to be allied to *C. semipapillatum*, Reuss, which is either a *Cerastoderma*, or perhaps a *Papyridea*.

66. *C. intermedium*, Reuss, is stated by Gümbel (loc. cit.) to be a young form of *C. productum*, Sow., with which also *C. alternans*, Rss., is identical. In place of the above species add *Lævicardium Brohei*, Briart et Cornet, (Foss. de Bracquegnies, 1868, p. 67, pl. vii, figs. 1—3, in Mém. Cour. Acad., Belg., xxxiv).

Family,—*HIPPURITIDÆ*.

On page 240, after the 4th line from top, add—

5. *Syndonites*, Pirona, differs from *Sphærulites*, and allied genera, by the absence of a cardinal fold, and by having the cardinal teeth grown together almost in their entire length. The typical species is *S. Stoppaniana*, Pir., from cretaceous beds of the Medea Hill in Friaul.

I am acquainted with this genus merely from a notice in the 'Sitzungsberichte' of the Geol. Institute, Vienna, for 1870, p. 222. It is published by Pirona, with many other new species of *HIPPURITIDÆ*, in the Mem. dell Inst. Veneto di scienze, V, xiv, for 1869.

On page 241 add—

79-91.—*Sphærulites Meneghiana*, *Visianica*, *Pasiniana*, *Guiscardiana*, *Medeensis*, *Catulli* and *ponderosa*; *Radiolites Zignoana*, *Gastaldiana*, *Taramelli*, *fascicularis* and *Masalongiana*, and *Syndonites Stoppaniana*, are described as new species by Prof. Pirona in a paper entitled "Le Hippuritidi del colle di Medea nel Friauli," published in Mem. dell Inst. Veneto di sc., V, xiv, for 1869.

A new species of a *Hippurite* is also described by Pirona, vol. xi, fasc. iii, of the *Atti della soc. ital. di sc. nat.* I have not seen the publication itself.

Family,—*LUCINIDÆ*.

On page 252 add—

17a. *Unicardium tumidum*, Briart et Cornet, (Foss. de Bracquegnies, 1868, p. 68, pl. vii, figs. 6-7, in *Mém. Cour. Acad., Belg.*, vol. xxxiv).

Family,—*UNGULINIDÆ*.

On page 261, at the end, add—

8. *Tenea*, Conrad, 1870, (*Am. Journ. Conch.*, VI, p. 72). Shell roundly ovate, thin, tumid; left valve under the apex with a \wedge -shaped tooth, the anterior lobe of which is continued along the anterior margin of the shell, separated by a deep groove from it; in the right valve are two cardinal teeth united above, the anterior is falcate, with a pit on each side, the posterior curved and directed obliquely backwards; type, *T. parilis* (*Mysia parilis*), Conrad, noticed under the latter name on p. 262, under No. 4.

Family,—*ASTARTIDÆ*.

On page 287 add—

127a. *Astarte ? staminea*, Conrad, (*Am. Journ. Conch.*, VI, p. 73,) from Ripley county, Mississippi.

143a. *Cardita corrugata*, Rss., (*tenuicosta* apud Reuss, *Boehmische Kreidef.*, p. 4). Gümbel (*Abhandl. Akad., München*, x, p. 568,) considers the Bohemian species as distinct from the English, and retains for it the name originally given to it by Reuss.

159a. *Cardita Konincki*, Briart et Cornet, (Foss. de Bracquegnies, 1868, p. 70, pl. vii, figs. 8-9, in *Mém. Cour. Acad., Belg.*, vol. xxxiv).

159b. *Cardita spinosa*, B. and C. (*ibidem* p. 71, pl. vii, figs. 12, 13, and 16).

Family,—*CRASSATELLIDÆ*.

On page 294, last line in the foot note, for No. 109, read 112.

On page 295—No. 65, *Crassatella Ratisbonensis*, Gümbel, (*Corresp.-Blatt des Zool. Min. Vereins zu Regensburg*, xxii, 1868, p. 66, pl. 1, fig. 4,) is based upon imperfect casts from the cretaceous beds near Regensburg.

Family,—*NUCULIDÆ*.

Page 327, No. 66. Gümbel (in *Neues Jahrbuch f. Mineralog.* for 1865, p. 148,) says that the original of *N. maxima* does not admit even of a generic determination. The name, as likewise that which follows, should be altogether omitted.

*Family,—ARCIDÆ.**On page 343—*

No. 133. Gümbel considers the species from the Bohemian Plæner, identified by Reuss with *Cucullæa glabra*, Park., as closely allied, if not identical, with *Trigonoarca Matheroniana*, d'Orb., (see Abhandl. Acad. Munich, x, p. 566).

Page 344, Nos. 156 and 161. Gümbel (loc. cit., p. 566,) speaks of the probable identity of *Barbatia Geinitzi* with *radiata*, (Münst.), (= *Arca subradiata*, d'Orb., non *Arca radiata*, Sow., which is probably a *Scapharca*).

Page 345 add—

220a. *Arca hercynica*, Gümbel, (Ostbayer. Grenzgeb., 1868, p. 766), is based upon a cast of a large species allied in form to *Trigonoarca Ligeriensis*, d'Orb.

*Family,—AVICULIDÆ.**On page 399—*

Nos. 47—49. The original specimens of these supposed three new species of *Avicula* all belong, according to Gümbel, (Neues Jahrb. f. Min., 1865, p. 147,) to a species of an eocene *Ostrea*, previously noticed by that author as allied to *O. inscripta*, d'Arch., and for which he proposes the name *O. diversalata*.

On page 401—

Nos. 173—174. These two supposed new species are, according to Gümbel, referable to *Inoceramus concentricus* (Neues Jahrbuch für Min., 1865, p. 147).

On page 402—

246. *Vulsella trigona*, Schafhäutl, is identical with *V. internostriata*, Gümbel, (Bayer. Alpengeb., 1861, p. 661, and Neues Jahrb. f. Min., 1865, p. 147), an eocene species. The same author also notices that the type of Münster's *V. falcata* is from the Kressenberg, apparently an eocene species. Both these species must be, therefore, eliminated from the list of cretaceous fossils.

CLASSIFIED LIST OF THE PELECYPODA KNOWN FROM THE CRETACEOUS ROCKS OF SOUTHERN INDIA.

Abbreviations of groups or formations—

Arr.=Arrialoore; Trich.=Trichinopoly; Oot.=Ootatoor; Val.=Valudayur; Ver.=Verdachelum.

Abbreviations of names of localities—

Alund.=Alundanapooram; And.=Andoor; Anap.=Anapaudy; Arr.=Arrialoore; Chock.=Chockanadapooram; Comar.=Comarapolliam; Coon.=Coonum; Cooll.=Coollpaudy; Cooth.=Coothoor; Cum.=Cumalipooram; Garud.=Garudamungalum; Kar.=Karpaudy; Kaud.=Kaudoor; Kaur.=Kauray; Kol.=Koloture; Kolak.=Kolakonuttom; Kul.=Kullay; Kull.=Kullygoody; Kun.=Kunnanore; Kurr.=Kurribiem; Maith.=Maithal; Mongl.=Monglepaudy; Mor.=Moraviatoor; Mull.=Mulloor; Ninn.=Ninnyoor; Od.=Odium; Olap.=Olapaudy; Oot.=Ootatoor; Ootac.=Ootacood; Ootac.=Ootacoil; Par.=Parally; Parch.=Parchairry; Pen.=Penangoor; Pond.=Pondicherry; Pood.=Poodoor; Poodp.=Poodoopolliam; Purav.=Puravoy; Serag.=Seraganoor; Serd.=Serdamungalum; Shill.=Shillagoody; Shut.=Shutanure; Shutg.=Shutamungalum; Stríp.=Strípermatúr; Vait.=Vaitagoody; Ver.=Vera-ghoor; Vyl.=Vylapaudy.

N. B.—Genera and species are numbered consecutively; the former in Roman, the latter in Arabic numbers.

No.	FAMILIES, GENERA, SPECIES, &C.	REFERENCES.		INDIAN.		FOREIGN.		REMARKS.
		Page.	Plate & Fig.	Localities.	Groups.	Localities.	Groups.	
	PHOLADACEA.	9						
	PHOLADIDÆ.	9						
	TEREDININÆ.	11						
I	TEREDO	13						
1	„ <i>partita</i> , Stol. ...	15	I, 1	Oot., Mor.	Oot.			
2	„ <i>crassula</i> , Stol. ...	16	I, 2	Oot. ...	Oot.			
3	„ <i>torulosa</i> , Stol. ...	16	I, 3	Mor. ...	Oot.			
4	„ [<i>Uperotes</i> ?] <i>glomerans</i> , Stol.	17	I, 4-5	Comar. ...	Arr.			
	PHOLADINÆ.	17						
II	TURNUS	19						
5	„ <i>lapidarius</i> , Stol.	23	I, 6	Odium ...	Oot.			
III	MARTESIA	20						
6	„ <i>tundens</i> , Stol.	24	II, 5-6	Mor. ...	Oot.			
IV	PARAPHOLAS	20						
7	„ <i>mersa</i> , Stol.	24	II, 7	Mor. ...	Oot.			
	GASTROCHÆNIDÆ.	25						
	ASTROCHÆNINÆ.	26						

No.	FAMILIES, GENERA, SPECIES, &C.	REFERENCES.		INDIAN.		FOREIGN.		REMARKS.
		Page.	Plate & Fig.	Localities.	Groups.	Localities.	Groups.	
	CLAVAGELLINÆ.	27						
	BRECHITINÆ.	28						
V	ROCELLARIA ...	26						
8	„ <i>guttula</i> , Stol.	30	I, 7	Od., Mor.	Oot.			
9	<i>Rocellaria</i> , <i>sp. ind.</i> ...	31	I, 8	Ninn. ...	Arr.			
VI	GASTROCHÆNA ...	26						
10	„ <i>aspergil-</i> <i>loides</i> , Forb.	31	I, 11,	Pond. ...	Arr.			
VII	CLAVAGELLA ...	27						
11	„ <i>semisulcata</i> , Forbes.	31	I, 9-10	Pond. ...	Val.			
	MYACEA.	32						
	MYIDÆ.	33						
	CORBULINÆ.	34						
	MYINÆ.	39						
VIII	CORBULA ...	35						
12	„ <i>striatuloides</i> , Forbes.	43	XVI, 13-14	Kol. ...	Trich.			
13	„ <i>parsura</i> , Stol.	44	I, 23-24, & XVI, 3-4.	Garud. ...	Trich.			
14	„ <i>minima</i> , d'Orb.	44	I, 19-22, & XVI, 7-12.	Odium ...	Oot.			
15	„ <i>cancellifera</i> , Stol.	45	I, 17, & XVI, 2.	Garud. ...	Trich.			
16	„ <i>exulans</i> , Stol.	45	I, 16 & 18, XVI, 1 & 5.	Arr. ...	Arr.			
IX	NEÆRA ...	37						
17	„ <i>mutua</i> , Stol. ...	46	III, 6, & XVI, 6.	Parch. ...	Trich.			
18	„ <i>detecta</i> , Stol. ...	46	III, 7, & XVI, 15.	Odium ...	Oot.			
X	POROMYA ...	38						
19	„ <i>globulosa</i> , Forb.	47	III, 8, & XVI, 16.	Comar. ...	Arr.			
20	„ <i>lata</i> , Forbes ...	47	II, 8-9, & XVI, 17.	Garud., Pond.	Trich & ? Val.			
21	„ <i>superba</i> , Stol. ...	48	III, 2-4	Garud., Kol.	Trich.			
	MACTRIDÆ.	49						
	LUTRARIINÆ.	50						
	MACTRINÆ.	53						

No.	FAMILIES, GENERA, SPECIES, &c.	REFERENCES:		INDIAN.		FOREIGN.		REMARKS.
		Page.	Plate & Fig.	Localities.	Groups.	Localities.	Groups.	
XI	MACTRA	54						
22	„ (<i>Schizodesma</i>) <i>tripartita</i> , Forb.	57	V, 8-11	Alund., Serd.	Trich.			
	<i>ANATINIDÆ.</i>	58						
	<i>PANDORINÆ.</i>	60						
	<i>THRACIINÆ.</i>	62						
	<i>ANATININÆ.</i>	65						
XII	CORIMYA	63						
23	„ <i>Oldhamiana</i> , Stol.	76	II, 14-16	Alund., Kun.	Trich.			
24	„ <i>pertusa</i> , Stol.	77	II, 12-13, & XVI, 18.	Pond. ...	Val.			
XIII	CEROMYA	66						
25	„ <i>subsinuata</i> , Forb.	78	IV, 4	Pond. ...	Val.			
XIV	ANATINA	68						
26	„ (<i>Cercomya</i>) <i>ar-</i> <i>cuata</i> , Forb.	78	III, 1	Pond. ...	Val.			
XV	PHOLADOMYA	70						
27	„ <i>caudata</i> , Röm.	79	II, 10-11, & XVI, 19.	Parch., Serd.	Trich. ...	Germany, Russia, Sweden, France.	Upper & middle cretaceous.	D'Orb.'s <i>Card. Sub-</i> <i>dinense</i> is a very closely allied species.
28	„ <i>connectans</i> , Forbes.	80	XVI, 29	Pond. ...	Val.			
29	„ <i>radiatula</i> , Stol.	80	III, 5	Garud., Serd., Alund.	Trich.			
30	„ <i>pedisulcata</i> , Stol.	81	IV, 1, and XVI, 26.	Garud., Anap.	Trich.			
	<i>SAXICAVIDÆ.</i>	81						
XVI	SAXICAVA	84						
31	„ <i>tenella</i> , Stol...	88	XVI, 20-24	N. of Od.	Oot.			
XVII	PANOPEA	85						
32	„ <i>orientalis</i> , Forb.	89	II, 1-4	Anap., Kol., Serd., Alund., Arr.	Trich. & Arr.			
	<i>GLAUCONOMYIDÆ.</i>	89						
	<i>SOLENIIDÆ.</i>	92						
XVIII	SILIQUA	95						
33	„ <i>limata</i> , Stol. ...	101	I, 12-13	S. E. of Parch., Garud.	Trich.			

No.	FAMILIES, GENERA, SPECIES, &C.	REFERENCES.		INDIAN.		FOREIGN.		REMARKS.
		Page.	Plate & Fig.	Localities.	Groups.	Localities.	Groups.	
XIX	PHARELLA	96						
34	„ <i>delicatula</i> , Stol.	101	I, 14	S. E. of Parch.	Trich.			
35	„ <i>obscura</i> , Forb.	101	I, 15	Pond. ...	Val.			
XX	TAGELUS	98						
36	„ <i>Albertinus</i> , d'Orb.	102	IV, 3	Comar. ...	Arr.			
	TELLINACEA.	103						
	<i>PAPHIIDÆ.</i>	104						
	<i>SCROBICULA- RIIDÆ.</i>	106						
	<i>CUMINGIINÆ.</i>	107						
	<i>SEMELINÆ.</i>	108						
	<i>TELLINIDÆ.</i>	112						
	<i>GARINÆ.</i>	113						
	<i>TELLININÆ.</i>	115						
	<i>CAPSINÆ.</i>	120						
XXI	TELLINA	116						
37	„ [<i>Tellinella</i>] <i>pe- trosa</i> , Stol.	125	XVI, 27-28	Garud. ...	Trich.			
38	„ [<i>Tellinella</i>] <i>arco- tensis</i> , Stol.	125	V, 2	Ninn. ...	Arr.			
39	„ [<i>Peronæoderma</i>] <i>scitulina</i> , Stol.	126	IV, 10-13, & XVI, 30.	Comar. ...	Arr.			
40	„ [<i>Tellinides</i>] <i>pri- mula</i> , Stol.	126	V, 1	Comar. ...	Arr.			
41	„ [<i>Arcopagia</i>] <i>mendosa</i> , Stol.	127	IV, 9	Od. ...	Oot.			
42	„ [<i>Arcopagia</i>] <i>dis- cites</i> , Stol.	128	IV, 15	Mor. ...	Oot.			
43	„ [<i>Tellinides</i>] <i>ad- pressa</i> , Stol.	128	IV, 14	Mor. ...	Oot.			
44	„ [<i>Palæomæra</i>] <i>in- conspicua</i> , Sow.	129	IV, 6-8.	Alund. & Serd.	Trich.			
45	„ [<i>Angulus</i>] <i>unda- ta</i> , Stol.	130	V, 3	Comar. ...	Arr.			
46	„ [<i>Linearia</i>] <i>semi- sculpta</i> , Stol.	130	V, 5	Serd. ...	Trich.			
47	„ [<i>Linearia</i>] <i>sculp- tilis</i> , Stol.	131	V, 6-7	Comar. ...	Arr.			
	<i>DONACIDÆ.</i>	131						
XXII	DONAX	133						

No.	FAMILIES, GENERA, SPECIES, &C.	REFERENCES.		INDIAN.		FOREIGN.		REMARKS.
		Page.	Plate & Fig.	Localities.	Groups.	Localities.	Groups.	
48	DONAX, <i>sp. ind.</i> ...	136	V, 4	S. E. Parch.	Trich.			
	VENERACEA.	136						
	<i>PETRICOLIDÆ.</i>	138						
	<i>VENERIDÆ.</i>	141						
	<i>TAPESINÆ.</i>	143						
	<i>VENERINÆ.</i>	146						
	<i>SUNETTINÆ.</i>	153						
XXIII	BARODA ...	145						
49	„ [<i>Icanotia</i>] <i>Pon-</i> <i>dicherriensis</i> , Forb.	167	IV, 5, & XVII, 4.	Mor. ...	Oot.			
50	„ [<i>Icanotia</i>] <i>eli-</i> <i>cita</i> , Stol.	168	IV, 16	N. of Kar.	Arr.			
XXIV	CYTHEREA ...	149						
51	„ [<i>Dosiniopsis</i>] <i>plana</i> , Sow.	169	VII, 1-4	N. of Alund. & N. of Kun.	Trich. ...	England, Germany, France.	Upper Greens.	D'Orbigny's <i>subplana</i> is placed by Coquand in his Dor- donien.
52	„ <i>Garudana</i> , Stol.	170	VI, 17-19	Comar. ...	Arr.			
53	„ <i>Arcotensis</i> , Forb.	171	XVI, 34	Trich.				
54	„ <i>crassula</i> , Stol.	171	VII, 10-17	N. Kun., N. E. Kar.	Arr.			
55	„ [<i>Callista</i>] <i>solitaria</i> , Stol.	172	V, 20	S. of Garud.	Trich.			
56	„ [<i>Callista</i>] <i>sculpturata</i> , Stol.	173	VII, 7-9	Kun. ...	Arr.			
57	„ [<i>Callista</i>] <i>fabu-</i> <i>lina</i> , Stol.	174	XVI, 31-33	Garud. & E. of Od.	Trich. & Oot.			
58	„ [<i>Callista</i>] <i>laci-</i> <i>niata</i> , Stol.	174	VII, 5-6	Ninn. ...	Arr.			
59	„ [<i>Callista</i>] <i>dis-</i> <i>coidalis</i> , Stol.	175	VII, 30-31	Ninn. ...	Arr.			
60	„ [<i>Callista</i>] <i>mi-</i> <i>nutula</i> , Stol.	175	VII, 18-20	Comar. ...	Arr.			
61	„ [<i>Callista</i>] <i>va-</i> <i>grans</i> , Stol.	176	VII, 21-23	Comar., N. E. of Kar., & Garud.	Arr. & Trich.			
62	„ [<i>Caryatis</i>] <i>tur-</i> <i>gidula</i> , Stol.	177	VII, 24-27	Od. ...	Oot.			
63	„ [<i>Caryatis</i>] <i>Telugensis</i> , Stol.	177	VII, 28-29	Comar. & Garud.	Arr. & Trich.			

No.	FAMILIES, GENERA, SPECIES, &C.	REFERENCES.		INDIAN.		FOREIGN.		REMARKS.
		Page.	Plate & Fig.	Localities.	Groups.	Localities.	Groups.	
64	CYTHEREA [<i>Caryatis</i>] <i>intercisa</i> , Stol.	178	VIII, 1-2	N. W. Kun. & N. Alund.	Trich.			
XXV	CYPRIMERIA	157						
65	„ <i>analoga</i> , Forbes.	178	V, 21-23	E. & S. E. Anap., N. Alund., S. E. Arr.	Trich. & Arr.			
66	„ <i>Oldhamiana</i> , Stol.	179	V, 24-25, & VI, 1-5.	Anap., N. Alund., & Garud.	Trich.			
67	„ <i>obesa</i> , d'Orb.	180	VII, 1-2	Ninn. ...	Arr.			
XXVI	ERIPHYLEA	156						
68	„ <i>lenticularis</i> , Goldf.	181	VI, 7-13	E. Anap., N. Serd., & near Olap.	Trich. ...	Germany	Upper cre- taceous beds.	Syn: <i>Lucina</i> <i>lenticularis</i> , Goldf.
69	„ <i>Forbesiana</i> , Stol.	181	VI, 14-16	Ninn. ...	Arr.			
70	„ <i>diversa</i> , Stol.	182	VI, 6	S. E. Vyl.	Arr.			
XXVII	THETIRONIA	158						
71	„ <i>ignobilis</i> , Stol.	485	L, 3	Pond. ...	? Valud.			
	<i>GLOSSIDÆ.</i>	183						
XXVIII	TRAPEZIUM	186						
72	„ <i>sp. ind.</i> ...	196	XIII, 4	N. Serd....	Trich.			
XXIX	VENIELLA	189						
73	„ [<i>Venilicardia</i>] <i>obtruncata</i> , Stol.	196	VIII, 4-7	Kol., Serd., Alund., Comar., Arr., Vyl., Olap.	Trich. & Arr.			
XXX	CYPRINA	191						
74	„ <i>Forbesiana</i> , Stol.	197	IX, 2-8	Alund., Serd., E. Anap., Kol.	Trich.			
75	„ <i>cristata</i> , Stol. ...	198	IX, 1	Arr. ...	Arr.			
76	„ [<i>Cicatreia</i>] <i>cordi-</i> <i>alis</i> , Stol.	199	X, 1-2	Serd. & Kol.	Trich.			
	<i>CYRENIDÆ.</i>	200						
	<i>CARDIIDÆ.</i>	204						
	<i>CARDIINÆ.</i>	207						
	<i>LYMNOCARDIINÆ.</i>	211						
XXXI	CARDIUM	207						
77	„ [<i>Trachycardium</i>] <i>incomptum</i> , Sow.	216	XI, 3-7	Anap., near Garud., Serd.	Trich.			

No.	FAMILIES, GENERA, SPECIES, &c.	REFERENCES.		INDIAN.		FOREIGN.		REMARKS.
		Page.	Plate & Fig.	Localities.	Groups.	Localities.	Groups.	
78	CARD. [<i>Trachycardium</i>] <i>exulans</i> , Stol.	216	XI, 11-13	S. E. Arr. and Olap.	Arr.			
79	„ [<i>Trachycardium</i>] <i>productum</i> , Sow.	317	XI, 15-16	Kol. ...	Oot. ...	Germany, Belgium, France, Gosau.	Senon. & Turon.	
80	„ [<i>Acanthocardium</i>] <i>pullatum</i> , Stol.	218	XI, 8-10	Vyl. and Anap.	Trich.			
81	„ [<i>Cerastoderma</i>] <i>pilatum</i> , Stol.	218	XIII, 6-7	Ninn. ...	Arr.			
82	„ [<i>? Pectunculus</i>] <i>scrobiculatum</i> , Stol.	219	XI, 14	Garud. ...	Trich.			
XXXII	PROTOCOLIDIUM ...	209						
83	„ <i>hillanum</i> , Sow.	219	XII, 8-10, XIII, 1-3.	Garud., Serd., Alund., Anap.	Trich. ...	England, France, Germany, Gosau.	Cenom., Turon., Senonien.	? Texas (teste Römer).
84	„ <i>delicatum</i> , Stol.	220	XIII, 8	Shutg. ...	Arr.			
85	„ <i>Pondicheriense</i> , d'Orb.	220	XII, 4-7	Anap., Alund.	Trich.			
86	„ <i>altum</i> , Sow.	221	XII, 1 & 3	Mongl., Od., Oot.	Oot.			
87	„ <i>bisectum</i> , Forb.	221	XII, 2	Mongl., Oot.	Oot.			
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98	„ <i>fallax</i> , Forbes	256	XIII, 13, 15-17, & XIV, 3-5, 7-8.	Mor., Ninn.	Oot., Arr.			
99	„ <i>undata</i> , Stol. ...	257	XIII, 14	S. E. Arr.	Arr.			
100	„ [<i>Cyclas</i>] <i>tanio-</i> <i>lata</i> , Stol.	257	XIII, 9	Ninn. ...	Arr.			
101	„ [<i>Myrtea</i>] <i>Arco-</i> <i>tina</i> , Stol.	258	XV, 1-5	Par., And., Olap.	Oot., Trich., Arr.			
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111	„ <i>Zitteliana</i> , Stol.	296	V, 15-19	Ninn. ...	Arr.			
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113	„ <i>tuberculifera</i> , Stol.	315	XV, 10-12	Coon. ...	Trich.			
114	„ <i>indica</i> , Stol.	315	XV, 14-15	S. E. Arr.	Arr.			
115	„ <i>orientalis</i> , Forb.	316	XV, 16-17	Comar. & near Pond.	Arr.			
116	„ <i>semiculta</i> , Forb.	317	XV, 19, 22, 23, 27.	Anap., N. E. Maithal.	Trich.			
117	„ <i>minuta</i> , Stol.	317	XV, 18, 20, 21.	Near Arr.	Arr.			
118	„ <i>crenifera</i> , Stol.	318	XV, 13	Olap. ...	Arr.			
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122	„ <i>obtusata</i> , Stol.	324	XVII, 7-10	Kar., Stríp.	Arr.			
123	„ <i>scaphuloidea</i> , Stol.	324	XVII, 11-12.	Comar. ...	Arr.			
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126	„ <i>sp. ind.</i> ...	329	XVII, 20	Od. ...	Oot.			
127	„ <i>crassica</i> , Stol.	329	XVII, 23	Kar. ...	Arr.			
128	„ <i>bidorsata</i> , Stol.	329	XVII, 22, 24-27.	Mor. ...	Oot.			
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131	„ <i>levicula</i> , Stol. ...	348	XLIX, 5-6	Arr., Pond.	Arr.			
132	„ <i>lattiusscula</i> , Stol.	348	XLIX, 9	Ootacoil, Ninn.	Arr.			
133	„ <i>subauriculata</i> , Forb.	349	XVII, 31-32.	Kun. ...	Arr.			
134	„ <i>cardioides</i> , d'Orb.	349	XVII, 33, L, 8.	Pond., Oot., Od., S. E. Serd.	Oot. Trich.			

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LVI	CUCULLÆA ...	337						
136	(?) „ <i>æquata</i> , Stol.	350	XVII, 34	Ninn. ...	Arr.			
LVII	MACRODON ...	336						
137	„ [? <i>Grammato-</i> <i>don</i>] <i>japeti-</i> <i>cum</i> , Forbes.	350	XVIII, 6-11.	Kar., Arr., Comar., Oote.	Arr.			
138	„ [? <i>Grammato-</i> <i>don</i>] <i>dispa-</i> <i>rile</i> , d'Orb.	351	XX, 6-7	Near Alund.	Trich.			
LVIII	TRIGONOARCA ...	337						
139	„ <i>Telugensis</i> , Stol.	352	XIX, 1	N. Alund.	Trich.			
140	„ <i>abrupta</i> , Forbes.	352	XIX, 4-5	Near Serd.	Trich.			
141	„ <i>Trichinopo-</i> <i>litensis</i> , Forbes.	353	XVIII, 12 & 14, XIX, 2-3, XX, 2, 8-10.	Anap., Garud., Serd., Alund.	Trich.			
142	„ <i>Gamana</i> , Forbes.	354	XX, 4-5, & L, 7.	Poodoor., Od., Mongl.	Oot. ...	...	...	Allied to <i>T. crassitesta</i> , Zitt., from the Gosau.
143	„ <i>Brahminica</i> , Forbes.	354	XVIII, 13, & XX, 1 & 3.	Kar., Arr., Mull., Comar.	Arr. ...	...	...	Closely allied to <i>T. Ma-theroniana</i> , d'Orb.
144	„ <i>Galdrina</i> , d'Orb.	355	XVIII, 2-5	E. Serd., near Stríp.	Arr.			
LIX	ANOMALOCARDIA ...	339						
145	„ [<i>Scapharca</i>] <i>Ponticeriana</i> , d'Orb.	355	XVII, 39, XVIII, 1.	N. E. Serd., near Shill.	Arr.			
146	„ [<i>Scapharca</i>] <i>Clellandi</i> , Forbes.	356	XVII, 35	Pond. ...	? Val.			
LX	BARBATIA ...	340						
147	„ <i>decora</i> , Stol.	356	XVII, 38	Ninn. ...	Arr.			
148	„ <i>diatreta</i> , Stol.	357	L, 9	S. E. Ver.	Trich.			
LXI	ARCA ...	341						
149	„ <i>flistriata</i> , Stol.	357	XVII, 37, L, 6.	N. Od. ...	Oot.			

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151	„ [<i>Botula</i>] <i>tumidula</i> , Stol.	375	XXIII, 16, & XXXVIII, 13.	S. E. Arr.	Arr.			
152	„ <i>curta</i> , Stol.	376	XXIII, 17	Od. ...	Oot.			
153	„ <i>subcylindrica</i> , Stol.	376	XXIII, 18-19.	Od. ...	Oot.			
LXIV	MODIOLA ...	370						
154	„ <i>typica</i> , Forb. ...	377	XXIII, 12-15.	Anap., Kol., Alund., Serd.	Trich. ...	Gosau. ...	Turon.	
155	„ <i>nitens</i> , Forb. ...	378	XXXVIII, 6.	Olap. ...	Arr.			
156	„ <i>polygona</i> , d'Orb.	378	XXIII, 10-11.	Pond. ...	Val.			
157	„ <i>flagellifera</i> , Forb.	379	XXIV, 1-2	Pond. ...	Val. (? Arr.)	Gosau & Transyl- vania & Belg.	Turon. & Senon.	
158	„ [<i>Brachydontes</i>] <i>radiatula</i> , Stol.	379	XXIII, 4, 6, 7.	Comar. ...	Arr.			
159	„ <i>annectans</i> , Stol.	380	XXIII, 8-9.	Vyl. ...	Arr.			
LXV	MYTILUS ...	371						
160	„ <i>Arrialoorensis</i> , Stol.	381	XXIII, 2, 3, 5.	Comar. ...	Arr.			
	PINNIDÆ.	381						
LXVI	PINNA ...	382						
161	„ <i>complanata</i> , Stol.	384	XXIV, 3-4	Kol., Anap., Alund.	Trich.			
162	„ <i>arata</i> , Forb. ...	384	XXIV, 5, XXV, 1, XXVI, 5.	Anap., Serd., Kol.	Trich.	Closely allied to <i>P. decus- sata</i> , Goldf.

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163	PINNA <i>laticostata</i> , Stol.	385	XXV, 2-3, XXVI, 4.	Comar., Oot.	Arr., Oot.			
164	„ <i>intumescens</i> , Stol.	385	XXVI, 2-3	Od. ...	Oot.			
165	„ <i>consobrina</i> , d'Orb.	385	L, 4	Pond. ...	Val. (?)			
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166	„ [<i>Oxytoma</i>] <i>semi-globosa</i> , Stol.	402	XXVI, 1	Kar. ...	Arr.			
167	„ [<i>Oxytoma</i>] <i>fal-laciola</i> , Stol.	403	XXXIII, 1, XXXVIII, 9-10.	Rajah- Choultry in Strip. district.	Arr.			
168	„ (?) <i>inops</i> , Stol.	403	XXXVIII, 7-8.	Rajah- Choultry.	Arr.			
LXVIII	AUCELLA ...	390						
169	„ <i>parva</i> , Stol.	404	XXXIII, 2-3.	Od. ...	Oot.			
LXIX	AVICULA ...	391						
170	„ [<i>Meleagrina</i>] <i>nitida</i> , Forb.	404	XXIV, 6-8, XXXVIII, 11-12.	Pond., Comar., Ver.	Arr.			
LXX	INOCERAMUS ...	393						
171	„ <i>Cripsianus</i> , Mant.	405	XXVII, 1-3, & XXVIII, 2.	Olap., Arr., Mait., N. W. Pood., N. E. & S. Kar.	Arr. ...	England, France, Germany, Gosau, Bohemia, &c., ? U. S., A.	Upper cre- taceous.	
172	„ <i>multiplicatus</i> , Stol.	406	XXVIII, 1	Kol., W. Garud., W. Kar., Alund.	Trich.			
173	„ <i>diversus</i> , Stol.	407	XXVII, 6	Anap. ...	Trich.			
174	„ <i>Geinitzianus</i> , Stol.	407	XXVII, 4-5.	S. W. Coon., Purav., Oot., Kal., Anap., Kolap., Garud.	Oot. & Trich.	? Saxony.	Plæner.	

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175	INOCERAMUS <i>labiatus</i> , Schlot.	408	XXIX, 1	N. E. Kaur., Od., Purav., Mor., Oot., Mongl.	Oot. ...	England, Germany, France, Bohemia, U. S. A., Texas.	Middle cre- taceous.	
176	„ <i>simplex</i> , Stol.	408	XXVIII, 3-4.	S. W. Mull., Arr., Olap.	Arr.			
LXXI	GERVILLEA	392						
177	„ <i>solenoides</i> , Def.	409	L, 5	Pond. ...	Val. (?)			
LXXII	MELINA	395						
178	„ <i>valida</i> , Stol. ...	409	XXII, 1	Kar., near Pood.	Arr.			
	OSTREACEA.	410						
	RADULIDÆ.	411						
LXXIII	RADULA	412						
179	„ [<i>Plagiostoma</i>] <i>nudata</i> , Stol.	417	XXIX, 2	Olap., Kar.	Arr.			
180	„ [<i>Plagiostoma</i>] <i>Ootatoorensis</i> , Stol.	417	XXIX, 3	Oot. ...	Oot.			
181	„ [<i>Plagiostoma</i>] <i>interpunctu- ata</i> , Stol.	417	XL, 5	N. E. Oot.	Oot.			
182	„ <i>insignis</i> , Stol.	418	XXX, 9	Near Mor.	Oot.			
183	„ <i>sp. indt.</i> ...	418	...	N. Kun.	Arr.			
184	„ <i>sp. indt.</i> ...	418	XL, 4	W. Pen.	Oot.			
185	„ <i>interplicosa</i> , Stol.	418	XXX, 10-11.	Ninn. ...	Arr.			
186	„ <i>sp. ind.</i> ...	419	XXXVI, 6	S. E. Arr.	Arr.			
187	„ <i>scabricula</i> , Stol.	419	XXX, 8	Comar. ...	Arr. ...	...	...	Closely allied to <i>R. granu- lata</i> , Nilss.
188	„ [<i>Limatula</i>] <i>per- similis</i> , Stol.	420	XXIX, 4-5	Near Poot., N. Od., Kullay.	Oot. ...	...	...	Closely allied to <i>R. semisul- cata</i> , Nilss.
189	„ [<i>Ctenoides</i>] <i>tecta</i> , Goldf.	420	XXX, 12	N. Pood.	Arr. ...	France, Germany, Bohemia, &c.	Upper cre- taceous.	
190	„ [<i>Ctenoides</i>] <i>sca- berrima</i> , Stol.	421	XXX, 1	Near Olap.	Arr.			
191	„ [<i>Acesta</i>] <i>obliqui- striata</i> , Forb.	421	XXX, 2-5, & 13.	Near Com., N. Arr. near Pood.	Arr.			

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192	RADULA [<i>Acesta</i>] <i>scrobiculata</i> , Stol.	422	XXIX, 6	Near Olap.	Arr.			
193	„ [<i>Ctenostreon</i>] <i>complanata</i> , Stol.	422	XXX, 14	Cull. ...	Oot.			
LXXIV	LIMEA	413						
194	„ <i>Oldhamiana</i> , Stol.	423	XXX, 6-7, & XXXVI, 5.	Stríp. ...	Arr. ...	...	...	Allied to <i>L. Cenomanensis</i> , Guér.
	<i>PECTINIDÆ</i> .	423						
LXXV	PECTEN	424						
195	„ <i>Anapaudiensis</i> , Stol.	431	XXXII, 1, & XL, 6.	Anap. ...	Trich. ...	...	...	Closely allied to <i>P. obliquus</i> , Sow.
196	„ <i>raduloides</i> , Stol.	431	XXXI, 20, XXXII, 2-3, & XLII, 6.	S. W. Mull., Arr., Karap., Ver.	Arr. ...	...	...	Allied to <i>P. undulatus</i> , Goldf.
197	„ <i>Verdachellensis</i> , Forb.	432	XXXI, 13-14, XLII, 7-8.	Oot., Purav., Mor.	Oot.			
198	„ <i>Arcotensis</i> , Stol.	432	XXXI, 18-19.	Stríp. ...	Arr.			
199	„ [<i>Chlamys</i>] <i>asperulinus</i> , Stol.	432	XXXI, 10-11, & XLIV, 5.	Kaud., Chock.	Arr.			
200	„ [<i>Camptonectes</i>] <i>curvatus</i> , Gein.	433	XXXI, 15-16, XLI, 4-6.	Arr., Kaud., Ver., Garud.	Arr. and Trich.	Belgium, Germany, France, Bohemia.	Upper and middle cretaceous.	Usually quoted as <i>P. virgatus</i> , Nilss.
201	„ [<i>Syncyclonema</i>] <i>obovatus</i> , Stol.	435	XXXII, 6-9.	Oot., Mor., Od., Purav.	Oot.			
202	„ [<i>Syncyclonema</i>] <i>Sivaicus</i> , Stol.	435	XLII, 5	Od. ...	Oot.			
203	„ [<i>Pseudam.</i>] <i>Garrudanus</i> , Stol.	435	XXXII, 4	Anap., Ver.	Trich.			
LXXVI	AMUSIUM	426						
204	„ <i>membranaceum</i> , Nilss.	436	XXXII, 5, XLI, 7-8.	Arr., Kar.	Arr. ...	Germany, Sweden, Galicia, Gosau, &c.	Upper and middle cretaceous.	
205	„ <i>illustre</i> , Stol.	436	XLI, 9	Arr. ...	Arr.			
206	„ <i>sulcatellum</i> , Stol.	436	XXXI, 12 & 17.	Arr. ...	Arr.	Allied to <i>Am. cretaceum</i> , Nyst.
LXXVII	VOILA	426						

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207	<i>VOLA quinquecostata</i> , Sow.	437	XXXI, 1-6, XXXVII, 4-9.	Od., Cull., Mor., Oot., Purav., Serd., Anap., Arr., Shill., Olap., Mull.	Oot., Trich, & Arr.	England, France, Germany, Austria, Spain, &c., &c.	Upper and middle cre- taceous.	
208	„ <i>lævis</i> , Drouet ...	438	XXXI, 7-8	Kullay, Coon., Od., Kolut.	Oot. ...	France & Germany, &c.	Middle cre- taceous.	= <i>Janira pha- seola</i> , Lam., <i>apud</i> d'Orb.
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CRETACEOUS PELECYPODA

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221	„ <i>ostracina</i> , Lam.	459	XXXV, 6-12, XXXVI, 1-4.	Vyl., S. E. Kau., E. Mulloor, Arr., Val.	Arr. ...	Europe generally, N. & S. America, Africa, Palæstine.	Upper cre- taceous.	
222	„ <i>laciniata</i> , Nilss.	460	XXXVIII, 1-3.	Ninn. ...	Arr. ...	Europe generally.	Upper cre- taceous.	
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224	„ <i>costata</i> , Say.	461	XL, 1-3, XLI, 1.	E. Poodoor.	Oot. ...	N. America	? Upper cre- taceous.	Closely allied to <i>Ex. Over- wegi</i> , Buch.
225	„ <i>Tamulica</i> , Stol.	462	XLI, 2-3, XLII, 1.	Near Arr.	Arr.			
226	„ <i>suborbiculata</i> , Lamck.	462	XXXV, 1-4	Pood., Mongl., N. E. Purav.	Oot. ...	Europe generally, & N. W. Asia.	Middle cre- taceous.	<i>Gryph. co- lumba</i> , Lam.
227	„ <i>canaliculata</i> , Sow.	463	XLVIII, 6-8.	N. by E. Od., W. by S. Illap.	Oot. ...	England, France, Germany, Belgium.	Middle cre- taceous.	
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230	„ <i>Ariana</i> , Stol.	465	XLIII, 2, XLIV, 1-3.	Comar. ...	Arr.			
231	„ <i>vesicularis</i> , Lamck.	465	XLII, 2-4, XLIII, 1, XLV, 7-12.	Comar., Arr., Ninn.	Arr. ...	Europe generally, N. Africa, W. Asia, N. Ame- rica, &c.	Upper cre- taceous.	
232	„ <i>vesiculosa</i> , Sow.	466	XXXIX, 1-2.	E. Pood., N. E. Od.	Oot. ...	Europe generally.	Middle cre- taceous.	

No.	FAMILIES, GENERA, SPECIES, &C.	REFERENCES.		INDIAN.		FOREIGN.		REMARKS.
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234	„ [<i>Alectryonia</i>] <i>cupelloides</i> , Stol.	467	XLVI, 4	Near Arr.	Arr.			
235	„ [<i>Alectryonia</i>] <i>amorpha</i> , Sow.	468	XLVIII, 3	Serd. ...	Trich.			
236	„ [<i>Alectryonia</i>] <i>carinata</i> , Lam.	468	XLVIII, 5, & XLIX, 1-2.	Coon., S. E. Ver., Od., Pood., Mor., Kul.	Trich. & Oot.	Europe generally, N. W. Asia, N. Africa.	Middle cre- taceous.	
237	„ [<i>Alectryonia</i>] <i>pectinata</i> , Lam.	469	XLVIII, 1-2.	Comar., Oot., Arr., Pood.	Arr. ...	Europe generally, N. Africa, America.	Upper cre- taceous.	
238	„ [<i>Alectryonia</i>] <i>ungulata</i> , Schloth.	470	XLVII, 3-4.	S. S. E. Oot., near Val. & Pond.	Arr. ...	Europe generally, N. Asia, Africa.	Upper cre- taceous.	
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241	„ <i>Telugensis</i> , Stol.	472	XLIX, 3-4, L, 1-2.	Near Comar.	Arr.	Allied to <i>O.</i> <i>Pasiphaë</i> , Coq.
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243	„ <i>variata</i> , Stol. ...	479	XLVIII, 9-12.	Comar. ...	Arr.			

GENERAL RESULTS DERIVED FROM THE EXAMINATION OF THE SOUTH INDIAN
CRETACEOUS PELECYPODA.

In a similar way, as I have done with the Cephalopoda and the Gastropoda,* I shall again briefly summarize the general palæontological and geological facts which have been derived from the study of the Pelecypoda. The richness of this class of Mollusca is equally great as that of the other classes already referred to, and among the various genera there are several which were up to date very imperfectly, or not at all, known to occur in cretaceous deposits. For this reason the study of the South Indian cretaceous Pelecypoda has been particularly interesting, and it is to be hoped that it will throw some light upon the correct generic determination of the cretaceous Pelecypoda in general.

I have described in the present volume 243 species, of which only very few are not characterized with sufficient detail, the materials for that purpose being as yet imperfect.

It is a noteworthy fact that the total (243) number of species of Pelecypoda is very nearly the same as that of the Gastropoda. The cretaceous (particularly the middle and upper) fauna holds in this respect an intermediate position. For during the kainozoic period the Gastropoda preponderate over the Pelecypoda, and the difference is still more marked within the recent epoch. On the contrary, during the jurassic period the Gastropoda are smaller in numbers when compared with the Pelecypoda, and the same is also the case in the preceding periods.

The 243 species are distributed in 9 orders and 31 families (out of 10 orders and 46 families into which I have respectively classed all known fossil and recent Pelecypoda). Of genera (including sub-genera—these not being separately counted) there are 85 represented out of the much larger number which I have noticed either recent or fossil (see Preface p. ix and seq.).

In order to indicate the zoological value of the examination of the South Indian cretaceous Pelecypoda, I shall briefly mention the number of species in each order: *PHOLADACEA* with 11; *MYACEA* with 25; *TELLINACEA* with 12; *VENERACEA* with 41; *CHAMACEA* with 4; *LUCINACEA* with 19; *ARCACEA* with 38; *MYTILACEA* with 29; *OSTREACEA* with 65. The only order of which no representative was found is that of the true fresh-water Pelecypoda, the *UNIONACEA*. The *OSTREACEA*, being the only true Monomyarian Pelecypoda, and of the lowest organization, are, as may be expected, most numerous. Of the other orders I would only allude to the *CHAMACEA* which are comparatively very little represented, although they include the almost exclusively cretaceous family *HIPPURITIDÆ*. This want seems to be due to the absence, or non-exposure, of coral-reefs and littoral cliffs.

In a geological point of view the results are equally interesting. The examination has, again, in general proved to be in favour of the tri-division into which the South Indian cretaceous deposits of the Trichinopoly district have been divided

* Palæontologia Indica, Vols. I and II, of the fauna of the South Indian cretaceous rocks.

by Mr. H. F. Blanford. The references to the three groups—Arrialore, Trichinopoly, and Ootatoor—have been, therefore, maintained, as likewise in the two former volumes. In a few cases I have noticed that these references appear a little doubtful, especially where the locality lies at the boundary of two groups or formation, but the error cannot be very great, and can easily be settled, when a revision of the country surveyed is made possible after a general study of the organic remains which the beds contain.

The Arrialore group proved again most prolific in species, their number being 106, a little more than two-fifths of the total. From the Trichinopoly group 51* were reported, and from the Ootatoor 69.†

To the Arrialore and Trichinopoly groups seven species are common, to the Trichinopoly and Ootatoor six, to the Arrialore and Ootatoor two, and only two species occur in all the three groups. These are comparatively very small proportions and show a distinctness of the faunas of the different groups, which could hardly have been anticipated.

Out of the total number (243) of species there are 29 identical with those from cretaceous deposits of Europe and other countries, giving approximately 12 per cent. By far the greater number of identifications is to be found among the lower organized orders, which is decidedly due in part to the more reliable records we possess of these fossils,‡ but in part it also appears to indicate that there formerly existed a greater uniformity in the general geographical distribution of the lower organised Pelecypoda, than can be proved in the higher organised orders.

Among the identical species there are many which are by all geologists regarded as the best characteristic fossils of the middle and cretaceous deposits of Europe, and some of which are already known also to occur in Western Asia, Africa and America, thus possessing a general geographical distribution. Among these characteristic fossils deserve special notice *Pholadomya caudata*, *Eryphila lenticularis*, *Cardium productum*, *Protocardium hillanum*, *Trigonia scabra*, *Modiola flagellifera* and *typica*, *Inoceramus Cripsianus* and *labiatus*, *Radula tecta*, *Pecten curvatus*, *Amusium membranaceum*, *Vola quinquecostata* and *lævis*, *Exogyra haliotoidea*, *lacinata* and *sub-orbiculata*, *Gryphæa vesicularis* and *vesiculosa*, *Ostrea diluviana*, *pectinata*, *carinata*, *ungulata*, and others. On the whole, however, the Pelecypod, as well as the Cephalopod, and Gastropod, fauna of Southern India, agrees with that of the so-called old continent, the American types being comparatively only very few. In the course of my descriptions I have repeatedly had occasion to notice that the present geographical distribution of several of the families and genera of Pelecypoda was clearly indicated already during the cretaceous period.

It is also worthy of notice how well the geological position of many of these characteristic species in Europe agrees with that in India, as may be inferred from the preceding table.

* Two of these are somewhat doubtful as to geological position, and of one species it is merely supposed that it belongs to the present group; the locality of the specimens not being ascertained.

† Several of these are doubtful, the difficulty arising chiefly from the uncertainty of the rocks at Pondicherry, whether they are Valudayur (=Ootatoor) group, or Arrialore group. More of the fossils appear to point to the latter division.

‡ Their shells being generally much better preserved than those of the higher orders.

Thus, for instance, *Inoc. Cripsianus*, *Eryph. lenticularis*, *Rad. tecta*, *Exog. laciniata*, *Gryph. vesicularis*, *Ost. unguolata*, and others are particularly characteristic of the upper cretaceous beds in Europe, and in India they are exclusively found in the Arrialoor beds. On the other hand, *Inoc. labiatus*, *Vola lævis*, *Exog. halio-toidea* and *sub-orbiculata* (= *columba*), *Gryph. vesiculosa*, *Ostrea diluviana*, and *carinata* characterize the middle cretaceous beds, chiefly the lower series, and they are restricted to the Ootatoor beds in India. Again, there are some, as *Card. productum*, *Protoc. hillanum*, *Vola quinquecostata*, *Pholadomya caudata*, *Amus. membranaceum*, and a few others, which in Europe occur in the middle and upper series of cretaceous deposits, and those species maintain a quite similar vertical distribution in India.

When Prof. E. Forbes first examined the invertebrate fauna of the South Indian cretaceous deposits he expressed himself in favour of their being of Neocomien age, the conclusions being apparently chiefly based upon the general character of the Cephalopoda. My first report in Vol. I of Pal. Indica showed that Forbes' views were untenable, but that there are to all appearance several species of Cephalopoda which are identical with others occurring in the Gault of Europe. Subsequently after my visit to Europe which was undertaken for the purpose of comparing Forbes' originals, and similar fossils in other collections, I reduced* a few of the identifications with Gault species, and I dare say, if sufficient materials for comparison were accessible, that number could still be lessened. When reporting upon the character of the Gastropod fauna (in Vol. II of Pal. Indica), I noticed only three Gastropoda which had a remarkably close resemblance to Gault species, but at the same time I pointed out that the character of the Gastropod fauna is decidedly upper and middle cretaceous.

The examination of the Pelecypoda has entirely confirmed this view, the more so that I have not been able to identify a single species with one from the Gault. There can be at the present, I believe, no doubt entertained against the view, that the cretaceous deposits of India correspond to the middle and upper cretaceous beds of Europe, namely, the Ootatoor and Trichinopoly groups represent d'Orbigny's *Cenomanien* and the lower part of the *Turonien*, or Coquand's principal divisions *Rotomagien* and *Carentonien*. The parallel is probably still better with the German 'Plæner.' The Ootatoor beds—with *Am. Rotomagensis* and *rostratus*, *Inoceramus labiatus*, *Exogyra suborbiculata*, *Gryph. vesiculosa*—evidently represent the lower Plæner; the Trichinopoly beds, (the fauna of which often does not appear to be very well defined from the previous,)—with *Am. peramplus*, &c., may be best identified with the middle Plæner.

The Arrialoor beds correspond to d'Orbigny's upper part of *Turonien* and to the *Senonien*, or to Coquand's chief divisions *Santonien* and *Campanien*. They are also perfectly equivalent to the upper Plæner of German geologists, characterized by *Amm. Gardeni*, *Inoceramus Cripsianus*, *Exogyra laciniata*, *Gryph. vesicularis*, and many others.

* Records Geological Survey of India, Vol. I, p. 32, &c.

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* = deaurata, Turton.

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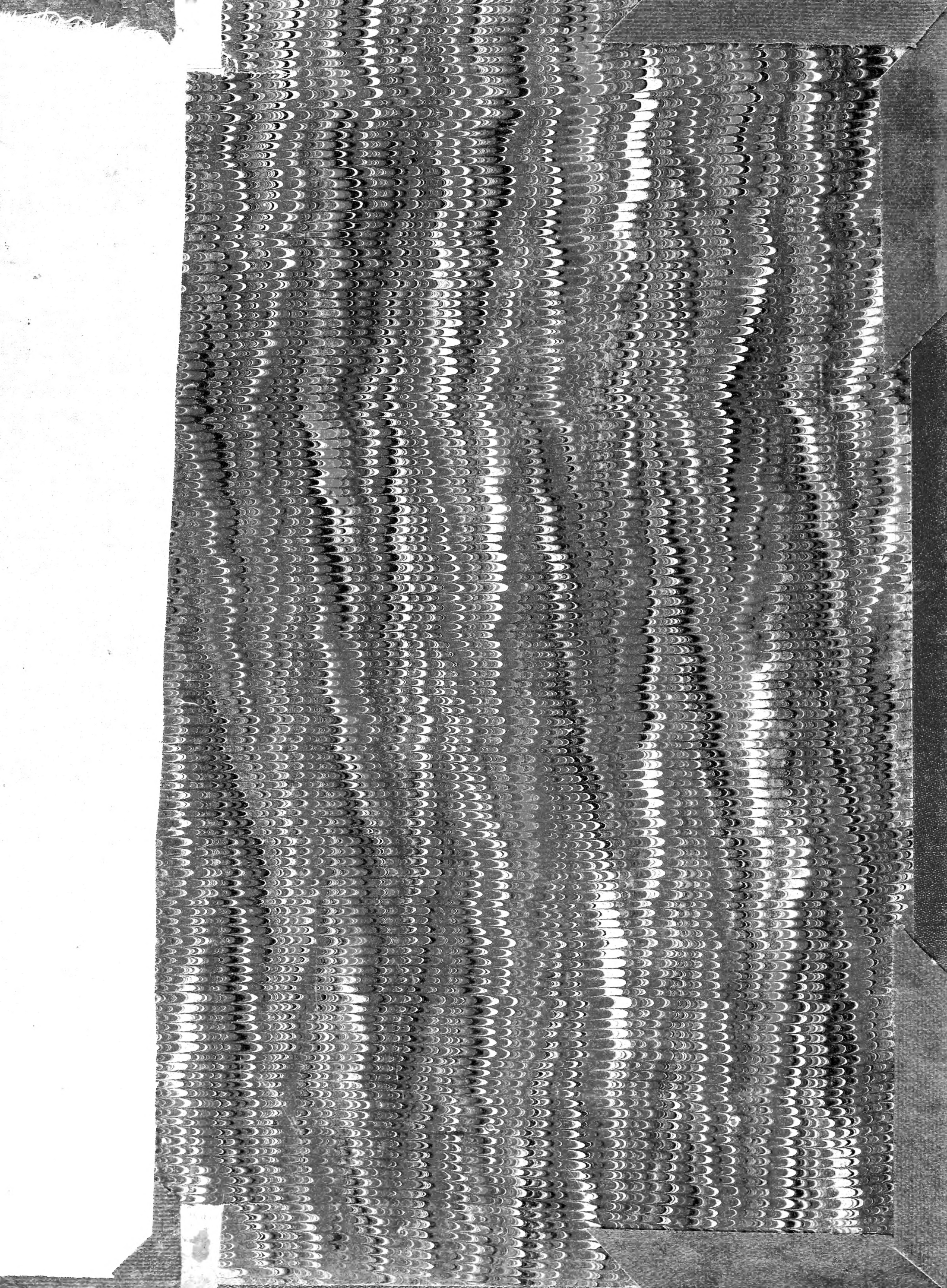
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[For several corrections in the text, see p. 480 and following pages].

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"	370,	"	19	"	"	' <i>spatiosus</i> '	"	' <i>spatiosa</i> .'
"	469,	"	17	"	"	"	"	"
"	469,	"	17	"	"	'Pl. XLVIII'	"	'Pl. XLIX.'
"	470,	"	14	"	"	"	"	"
"	470,	"	14	"	"	'Figs. 3-4'	"	'Figs. 3-5.'





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